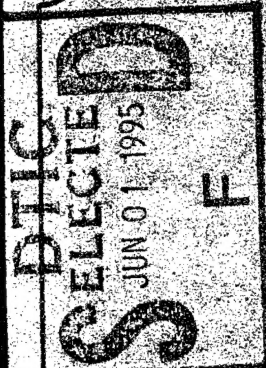
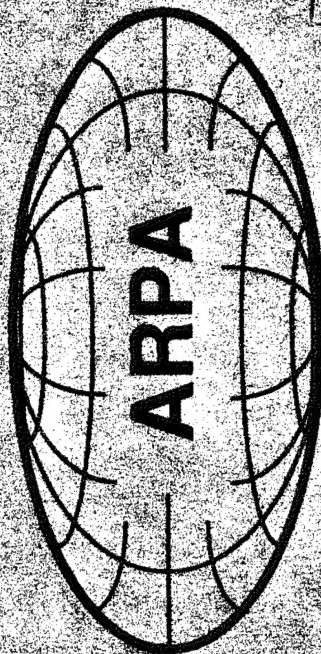


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**Program Objectives Memorandum
(POM 95-99)
RDT&E Descriptive Summaries**



September 1993

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ADVANCED RESEARCH PROJECTS AGENCY
3701 NORTH FAIRFAX DRIVE
ARLINGTON, VA 22203-1714




OCT 08 1993

MEMORANDUM FOR THE SECRETARY OF DEFENSE

SUBJECT: POM 95-99 Submission

Attached is the ARPA Program Objectives Memorandum submission covering RDT&E requirements for FYs 1995-99. The programs have been structured to provide a balance between the seven DoD focused technology thrust areas and ARPA core programs in the Basic Sciences, High Performance Computing and Communications, Advanced Materials Processing, Manufacturing Technologies and System Demonstrations. Funding for the Technology Reinvestment Program has been maintained at the FY 1994 level in keeping with the Defense Guidance.


Gary L. Denman
Director

Attachment

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ADVANCED RESEARCH PROJECTS AGENCY

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SECTION I

EXECUTIVE SUMMARY

Advanced Research Project Agency POM 1995-99 Executive Summary

The mission of the Advanced Research Projects Agency (ARPA) is to pursue high risk, technologically challenging research and development that will provide the basis for next generation weapons systems, tactics, and training. The FY 1995-99 POM reflects ARPA's continuing commitment to its overall mission.

Research activities funded by the FY 1995-99 POM can be broadly categorized into such areas as basic research; High Performance Computing/software; sensor technologies; advanced simulation; warfare/weapons development; special access activities; and manufacturing science and technology. Included within these categories is the funding necessary to continue advanced technology demonstrations and core research programs, and begin a small number of new initiatives.

Core Programs

To the greatest extent possible, funding levels for basic research have been maintained at prior year levels in recognition of the importance of "pure" scientific research. Research centering on advanced materials, ultra-fast communications and electronic information processing, intelligent information systems and robotics fall within this category.

Major programs in the area of computers and software are the High Performance Computing project and the Intelligent Systems and Software program. ARPA is a major participant in the multi-agency Federal High Performance Computing and Communications program that will be the cornerstone of the National Information Infrastructure. Harnessing the potential power of such computer architectures as scalable massively parallel systems and developing the software necessary to efficiently operate them will be an ARPA focus for the rest of the decade.

A comprehensive effort to identify, track and prosecute time critical targets, called WAR BREAKER, will continue. Other sensor-related activities funded in the POM include the Air Defense Initiative and Anti-Submarine Warfare research.

The National Guard simulation program is restored to the FY 1993 level in the POM. The FY 1995 Advanced Simulation program has been increased to expand on-going efforts, particularly the Synthetic Theater of War demonstration.

A number of developmental projects are funded within the area of electronic warfare, weapons and vehicles including Advanced Submarine Technology improvements, and continuation of the ASTOVL aircraft demonstration.

In March 1993, ARPA's charter was revised to underscore the importance of dual-use technology development activities, and the Manufacturing Technology program now represents approximately 50 percent of ARPA's core program. The major, and most publicized program is the Technology Reinvestment Project, formerly called Defense Conversion. POM funding for this effort has been maintained at the FY 1994 level. A number of other dual-use projects are also funded in the areas of materials processing technology, electronic processing technology, electronic module technology, and high definition systems, as well as continued participation in the SEMATECH consortium.

New Initiatives

A small number of new initiatives have been funded in the POM. Several computer/software projects have been introduced including establishment of an information infrastructure project, enhancements to human computer interaction, development of a common grid, and initiation of a defensive software program. A medical research program will be initiated that will focus on battlefield trauma care and medical information infrastructure. A comprehensive battlefield management project has been funded to more accurately simulate the battlefield environment, improve command, control and communications capabilities and improve troop training. In the area of dual-use technology, a hybrid electric vehicle program and several design and manufacturing projects are funded. Funds for environmental research initiatives, research into promising advanced materials, and a low power electronics program have also been provided.

Program Uncertainties

Although every attempt was made to address ARPA's funding requirements within topline guidance, several areas of program uncertainty remain. The White House MARITECH shipbuilding initiative was only recently unveiled and is currently unfunded. While much of the funding responsibility falls to the Department of Transportation, approximately \$190 million will be required to fund the outyear shipbuilding-related research portion of the project that is a DoD responsibility. Maintenance of Dual-Use and Technology Reinvestment Project funding levels penalized several on-going projects. Restoration of these shortfalls would require approximately \$50 million per year. However, the larger question with regard to the Technology Reinvestment Project concerns the appropriate level of FY 1995-99 funding

given the likely FY 1994 budget increase under consideration by the Congress. Three of four defense oversight committees have proposed adding \$300 million to the Technology Reinvestment Project, effectively doubling the FY 1994 budget request of \$324 million. The programmed \$325 million FY 1995 program, while consistent with previous budget levels, may no longer be adequate to sustain efforts initiated in prior years.

ADVANCED RESEARCH PROJECTS AGENCY RESEARCH, DEVELOPMENT, TEST AND EVALUATION, DEFENSEWIDE PROGRAM SUMMARY - BY APPROPRIATION (FISCAL GUIDANCE) (\$ in millions)							
POM 95-99							
Appropriation	FY 1993	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999

RDTE&E, Defensewide	2,274.6	2,182.2	2,408.2	2,410.1	2,411.6	2,543.0	2,476.7
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ADVANCED RESEARCH PROJECTS AGENCY
RESEARCH, DEVELOPMENT, TEST AND EVALUATION, DEFENSEWIDE
SUMMARY BY BUDGET ACTIVITY
(\$ In Thousands)

POM 95-99

	FY 1993 Actual	FY 1994 Estimate	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate
1 Technology Base	961,576	846,792	925,259	883,588	963,446	1,054,569	1,104,053
2 Advanced Technology Development	1,244,632	1,278,558	1,424,108	1,467,079	1,388,034	1,428,639	1,310,715
6 Defensewide Mission Support	<u>68,424</u>	<u>56,814</u>	<u>58,881</u>	<u>59,439</u>	<u>60,135</u>	<u>59,794</u>	<u>61,945</u>
TOTAL RDT&E - DIRECT	2,274,632	2,182,164	2,408,248	2,410,106	2,411,615	2,543,002	2,476,713
Reimbursements	<u>15,000</u>	<u>10,000</u>	<u>10,000</u>	<u>10,000</u>	<u>10,000</u>	<u>10,000</u>	<u>10,000</u>
TOTAL PROGRAM	2,289,632	2,192,164	2,418,248	2,420,106	2,421,615	2,553,002	2,486,713

ADVANCED RESEARCH PROJECTS AGENCY
RESEARCH, DEVELOPMENT, TEST AND EVALUATION, DEFENSEWIDE
SUMMARY BY PROGRAM CATEGORY
(\$ In Thousands)

POM 95-99

	FY 1993 Actual	FY 1994 Estimate	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate
6.1 Research	109,559	79,657	70,498	59,863	62,004	62,282	62,607
6.2 Exploratory Development	852,017	767,135	854,761	823,725	901,442	992,287	1,041,446
6.3 Advanced Development	1,244,632	1,278,558	1,424,108	1,467,079	1,388,034	1,428,639	1,310,715
6.5 Management and Support	<u>68,424</u>	<u>56,814</u>	<u>58,881</u>	<u>59,439</u>	<u>60,135</u>	<u>59,794</u>	<u>61,945</u>
Total Research and Development (Program 6)	2,274,632	2,182,164	2,408,248	2,410,106	2,411,615	2,543,002	2,476,713
Reimbursements	<u>15,000</u>	<u>10,000</u>	<u>10,000</u>	<u>10,000</u>	<u>10,000</u>	<u>10,000</u>	<u>10,000</u>
TOTAL PROGRAM	2,289,632	2,192,164	2,418,248	2,420,106	2,421,615	2,553,002	2,486,713

DEPARTMENT OF DEFENSE - MILITARY
ADVANCED RESEARCH PROJECTS AGENCY
RESEARCH, DEVELOPMENT, TEST AND EVALUATION, DEFENSEWIDE
DETAIL BY BUDGET ACTIVITY
 (\$ in Thousands)

POM 95-99

Element Code	Title	FY 1993 Actual	FY 1994 Estimate	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate
1	Technology Base							
6.1	Basic Research							
0601101E	Defense Research Sciences	109,559	79,657	70,498	59,863	62,004	62,282	62,607
		109,559	79,657	70,498	59,863	62,004	62,282	62,607
6.2	Exploratory Development	852,017	767,135	854,761	823,725	901,442	992,287	1,041,446
0602301E	Computing Systems & Communications Tech	348,329	366,706	414,798	416,914	463,790	503,987	525,761
0602702E	Tactical Technology	97,122	143,891	133,583	105,956	126,102	154,021	195,124
0602708E	Integrated Command & Control Tech	152,180	57,214	50,000	50,000	50,000	65,464	50,000
0602712E	Materials & Electronics Technology	254,386	199,324	256,380	250,855	261,550	268,815	270,561
2	Advanced Technology Development							
6.3	Advanced Development	1,244,632	1,278,558	1,424,108	1,467,079	1,388,034	1,428,639	1,310,715
0603226E	EEMT	286,969	512,198	611,759	598,003	600,221	672,348	635,312
0603569E	Advanced Submarine Technology	52,952	32,556	29,576	27,273	35,234	34,883	36,230
0603570E	Defense Reinvestment	561,633	324,000	325,000	325,000	325,000	321,000	320,000
0603739E	Electronics Manufacturing Technology	219,847	300,597	346,342	405,904	322,879	310,408	229,173
0603744E	Advanced Simulation - National Guard	28,521	9,207	21,431	20,899	14,700	0	0
0603745E	SEMATECH	94,710	100,000	90,000	90,000	90,000	90,000	90,000
6	Defensewide Mission Support							
6.5	Management and Support	68,424	56,814	58,881	59,439	60,135	59,794	61,945
0305889E	DoD Intelligence Support to Counternarcotics	26,361	0	0	0	0	0	0
0605114E	Blacklite	4,770	4,875	4,875	4,778	4,730	4,683	4,634
0605502E	Small Business Innovation Research	16,531	0	0	0	0	0	0
0605898E	Management Headquarters (R&D)	20,762	24,066	25,635	25,993	27,027	27,015	29,507
0901600E	Contract Administration/Audit	0	27,873	28,371	28,668	28,378	28,096	27,804
	Total ARPA	2,274,632	2,182,164	2,408,248	2,410,106	2,411,615	2,543,002	2,476,713

**ADVANCED RESEARCH PROJECTS AGENCY
RESEARCH, DEVELOPMENT, TEST AND EVALUATION, DEFENSE AGENCIES
PROJECT LEVEL SUMMARY REPORT
(\$ in millions)**

POM 95-99

DE	PROJECT	TITLE	FY93	FY94	FY95	FY96	FY97	FY98	FY99
61101E	CCS-02	INFORMATION SCIENCES	49.176	33.677	24.569	20.414	18.568	17.960	18.021
	ES-01	ELECTRONIC SCIENCES	34.791	31.853	35.073	23.468	24.835	24.560	25.333
	MS-01	MATERIALS SCIENCES	25.592	14.127	10.856	15.981	18.601	19.762	19.253
61101E		DEFENSE RESEARCH SCIENCES	109.559	79.657	70.498	59.863	62.004	62.282	62.607
62301E	ST-01	JASONS	1.240	1.240	1.227	1.218	1.203	1.190	1.178
	ST-10	STRATEGIC COMPUTING	68.246	0.000	0.000	0.000	0.000	0.000	0.000
	ST-11	INTELLIGENT SYSTEMS & SOFTWARE	38.831	68.841	89.798	102.726	115.284	151.034	150.447
	ST-12	ADV QUANTUM ELECTRO-OPTICS	8.653	0.000	0.000	0.000	0.000	0.000	0.000
	ST-19	HIGH PERFORMANCE COMPUTING	133.107	236.043	241.717	242.191	267.360	264.683	284.774
	ST-20	DIST INFO SYSTEMS/C3	34.352	0.000	0.000	0.000	0.000	0.000	0.000
	ST-21	SOFTWARE ENGINEERING INST (SEI)	15.635	0.000	0.000	0.000	0.000	0.000	0.000
	ST-22	SOFTWARE ENGINEERING TECH	21.814	39.096	40.740	19.562	19.205	18.678	20.250
	ST-23	SURVEILLANCE RESEARCH	26.451	21.486	41.316	51.217	60.738	68.402	69.112
62301E		COMPUTING SYS & COMM TECH	348.329	366.706	414.798	416.914	463.790	503.987	525.761
62702E	TT-03	NAVAL WARFARE TECHNOLOGY	33.154	33.828	39.883	38.728	39.211	43.396	45.107
	TT-04	CLOSE COMBAT TECHNOLOGY	4.686	28.300	22.444	10.210	20.230	28.154	56.549
	TT-05	ADVANCED TARGETING TECH	14.663	48.098	36.348	29.876	30.518	34.791	35.597
	TT-06	ADVANCED TACTICAL TECH	19.369	26.285	34.908	27.142	36.143	47.680	57.871
	TT-07	AERONAUTICS TECHNOLOGY	25.250	7.380	0.000	0.000	0.000	0.000	0.000
62702E		TACTICAL TECHNOLOGY	97.122	143.891	133.583	105.956	126.102	154.021	195.124
62708E	IC-03	HIGH DEFINITION SYSTEMS	152.180	57.214	50.000	50.000	50.000	65.464	50.000
62708E		INT COMMAND & CONTROL TECH	152.180	57.214	50.000	50.000	50.000	65.464	50.000
62712E	MPT-01	MATERIALS PROCESSING TECH	73.684	81.047	110.197	109.058	128.620	143.565	154.108
	MPT-02	ELECTRONIC PROCESSING TECH	37.202	80.489	105.929	101.797	104.928	104.252	116.453
	MPT-03	OPTOELECTRONICS/GAAS	36.877	0.000	0.000	0.000	0.000	0.000	0.000
	MPT-04	ADVANCED LITHOGRAPHY	71.162	0.000	0.000	0.000	0.000	0.000	0.000
	MPT-06	HTS/HIGH TEMP SUPER CONDUCTORS	35.461	37.788	14.238	10.000	0.000	0.000	0.000
	MPT-07	MILITARY MEDICAL/TRAUMA CARE TECH	0.000	0.000	26.016	30.000	28.002	20.998	0.000
62712E		MATERIALS & ELECTRONICS TECH	254.386	199.324	256.380	250.855	261.550	268.815	270.561

**ADVANCED RESEARCH PROJECTS AGENCY
RESEARCH, DEVELOPMENT, TEST AND EVALUATION, DEFENSE AGENCIES
PROJECT LEVEL SUMMARY REPORT
(\$ in millions)**

POM 95-99

DE	PROJECT	TITLE	FY93	FY94	FY95	FY96	FY97	FY98	FY99
63226E	EE-21	CLOSE COMBAT	0.000	0.000	27.750	33.750	44.06C	53.960	48.282
	EE-23	ENHANCED FIGHTER MANEUVER	8.758	0.000	0.000	0.000	0.000	0.000	0.000
	EE-24	ASTOVL	4.770	19.712	19.039	1.954	0.000	0.000	0.000
	EE-27	ADV SPACE TECH PROGRAM	14.711	30.213	11.435	11.944	12.014	4.031	7.745
	EE-30	SMART WEAPONS APPL PROG	7.203	0.000	0.000	0.000	0.000	0.000	0.000
	EE-34	GUIDANCE TECHNOLOGY	13.260	6.329	10.907	18.937	16.000	15.000	0.000
	EE-36	ADVANCED ASW TECHNOLOGY	10.721	13.680	18.385	18.692	18.496	22.614	23.550
	EE-37	ADVANCED SIMULATION	43.443	55.993	80.368	76.897	40.675	65.003	54.978
	EE-39	UNMANNED UNDERSEA VEHICLE SYS	15.880	17.952	17.839	17.900	17.571	17.395	18.115
	EE-40	CRITICAL MOBILE TARGETS	34.724	104.553	124.654	117.537	114.303	113.162	115.795
	EE-41	AIR DEFENSE INITIATIVE	0.000	27.717	40.600	31.600	32.000	41.000	41.000
	EE-43	ALTERNATIVE POWER SOURCES	54.539	0.000	10.000	14.488	24.514	30.000	30.000
	EE-44	WINGSHIP	5.000	0.000	0.000	0.000	0.000	0.000	0.000
	EE-45	GLOBAL GRID COMMUNICATIONS	0.000	20.881	42.843	45.926	39.842	32.592	5.435
	EE-CLS	CLASSIFIED	73.960	215.168	207.939	208.378	240.746	277.591	290.412
	63226E	EEMT	286.969	512.198	611.759	598.003	600.221	672.348	635.312
63569E	AS-01	ADVANCED SUBMARINE TECH	52.952	32.556	29.576	27.273	35.234	34.883	36.230
	PT-01	DUAL USE TECH PARTNERSHIPS	95.177	0.000	0.000	0.000	0.000	0.000	0.000
63570E	PT-03	COM-MIL INTEGRATION PARTNERSHIPS	47.588	0.000	0.000	0.000	0.000	0.000	0.000
	PT-04	REGIONAL TECHNOLOGY ALLIANCES	95.177	0.000	0.000	0.000	0.000	0.000	0.000
	PT-05	DUAL USE EXT ASST PROGRAM	95.177	0.000	0.000	0.000	0.000	0.000	0.000
	PT-06	AGILE MFG ENTERPRISE INTEGRATION	28.553	0.000	0.000	0.000	0.000	0.000	0.000
	PT-07	ADV MATERIALS PARTNERSHIP	28.553	0.000	0.000	0.000	0.000	0.000	0.000
	PT-08	ADV MAN TECH PARTNERSHIPS	23.805	0.000	0.000	0.000	0.000	0.000	0.000
	PT-09	MANUF EXT SERVICE	95.229	0.000	0.000	0.000	0.000	0.000	0.000
	PT-10	MGF ENG EDUCATION PROGRAM	28.566	0.000	0.000	0.000	0.000	0.000	0.000
	PT-11	MISC MAN TECH	23.808	0.000	0.000	0.000	0.000	0.000	0.000
	PT-99	DEFENSE REINVESTMENT	0.000	324.000	325.000	325.000	325.000	321.000	320.000
	63570E	DEFENSE REINVESTMENT	561.633	324.000	325.000	325.000	325.000	321.000	320.000

ADVANCED RESEARCH PROJECTS AGENCY
RESEARCH, DEVELOPMENT, TEST AND EVALUATION, DEFENSE AGENCIES
PROJECT LEVEL SUMMARY REPORT
(\$ in millions)

POM 95-99

RE	PROJECT	TITLE	FY93	FY94	FY95	FY96	FY97	FY98	FY99
63739E	MT-02	MMIC	81.579	80.181	17.188	0.000	0.000	0.000	0.000
	MT-03	INFRARED FOCAL PLANE ARRAY	34.150	41.429	45.100	43.200	14.400	0.000	0.000
	MT-04	ELECTRONIC MODULE TECH	66.376	98.080	132.648	146.512	83.426	99.502	84.472
	MT-05	TACTICAL DISPLAY SYSTEMS	10.078	9.467	15.407	21.161	19.894	17.000	15.500
	MT-06	MICROWAVE & ANALOG FRONT END TECH	0.000	0.000	36.002	49.634	63.936	79.980	84.201
	MT-07	CENTERS OF EXCELLENCE	27.664	4.837	0.000	0.000	0.000	0.000	0.000
	MT-08	MANUFACTURING TECH INITIATIVES	0.000	19.146	44.433	70.655	64.472	49.691	0.000
	MT-09	DUAL-USE DESIGN & MANUFAC TECH	0.000	0.000	30.564	49.742	51.751	39.235	20.000
	MT-10	ADVANCED LITHOGRAPHY	0.000	47.457	25.000	25.000	25.000	25.000	25.000
63739E		ELECTRONICS MANUFAC TECH	219.847	300.597	346.342	405.904	322.879	310.408	229.173
63744E	SM-01	ADVANCED SIMULATION - NAT GUARD	28.521	9.207	21.431	20.899	14.700	0.000	0.000
63745E	EM-01	SEMATECH	94.710	100.000	90.000	90.000	90.000	90.000	90.000
35889E	1403	CONTAINER DETECTION & CD RESCH	26.361	0.000	0.000	0.000	0.000	0.000	0.000
	35889E	DOD INTEL SUPPORT TO CN	26.361	0.000	0.000	0.000	0.000	0.000	0.000
65114E	BL-01	BLACKLITE	4.770	4.875	4.875	4.778	4.730	4.683	4.634
65502E	SB-01	SMALL BUSINESS	16.531	0.000	0.000	0.000	0.000	0.000	0.000
65898E	MH-01	MANAGEMENT HEADQUARTERS	20.762	24.066	25.635	25.993	27.027	27.015	29.507
91600E	AA-01	CONTRACT ADMINISTRATION/AUDIT	0.000	27.873	28.371	28.668	28.378	28.096	27.804
		AGENCY TOTAL	2274.632	2182.164	2408.248	2410.106	2411.615	2543.002	2476.713
	BA-01	TOTAL	961.576	846.792	925.259	883.588	963.446	1054.569	1104.053
	BA-02	TOTAL	1244.632	1278.558	1424.108	1467.079	1388.034	1428.639	1310.715
	BA-06	TOTAL	68.424	56.814	58.881	59.439	60.135	59.794	61.945
		AGENCY TOTAL	2274.632	2182.164	2408.248	2410.106	2411.615	2543.002	2476.713

SECTION II

MODERNIZATION AND INVESTMENT

UNCLASSIFIED

FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0601101E
PE Title: Defense Research Sciences

Date: September 1993
Budget Activity: 1. Technology Base

A. (U) RESOURCES (\$ In Thousands)

Project Number & Title	FY 1993 Actual	FY 1994 Estimate	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	To Complete	Total Program
CCS-02									
Information Sciences									
	49,176	33,677	24,569	20,414	18,568	17,960	18,021	Continuing	Continuing
ES-01									
Electronic Sciences									
	34,791	31,853	35,073	23,468	24,835	24,560	25,333	Continuing	Continuing
MS-01									
Materials Sciences									
	25,592	14,127	10,856	15,981	18,601	19,762	19,253	Continuing	Continuing
TOTAL	109,559	79,657	70,498	59,863	62,004	62,282	62,607		

B. (U) BRIEF DESCRIPTION OF PROJECT: The Defense Research Sciences program element provides the technical foundation for long-term improvements through the discovery of new phenomena and the exploration of the potential of such phenomena for military, national security and commercial applications. It supports the scientific study and experimentation that is the basis for more advanced knowledge and understanding in information, electronic and materials sciences. The programs contained in this Program Element also reflect the Department's initiative to support Technology Reinvestment.

(U) The Information Sciences project supports the scientific study and experimentation that is the basis for more advanced knowledge in software technology, intelligent systems technology, human-computer interaction technology, facets of microelectronic sciences, and varied aspects of high performance computing.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0601101E

Date: September 1993

PE Title: Defense Research Sciences

Budget Activity: 1. Technology Base

(U) The Electronic Sciences project explores and demonstrates new technical options for future electronic and optoelectronic devices, circuits, and processing. It focuses on the transmission, gathering and processing of information at a substantial increase in performance and cost reduction per function.

(U) The Materials Sciences project concentrates on the development and exploitation of biologically-derived materials, magnetic composite materials, biosensors for battlefield trauma care, and high power/energy density power sources. It encompasses research on disposal of toxic chemical waste and waste source reduction related to manufacturing processes.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0601101E Project Number: CCS-02 Date: September 1993
 PE Title: Defense Research Sciences Budget Activity: 1. Technology Base

A. (U) RESOURCES: (\$ In Thousands)

Project: Number & Title	FY 1993		FY 1994		FY 1995		FY 1996		FY 1997		FY 1998		FY 1999		To	Total
	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Complete	Program	
CCS-02	Information Sciences															
	49,176	33,677	24,569	20,414	18,568	17,960	18,021	Continuing	Continuing	Continuing	Continuing	Continuing	Continuing	Continuing	Continuing	

B. (U) BRIEF DESCRIPTION OF PROJECT: This project supports the scientific study and experimentation that is the basis for more advanced knowledge and understanding in information Sciences related to long-term national security and commercial needs.

(U) Software technology develops advanced concepts for methods and tools to produce high assurance software, language concepts that facilitate the rapid specification and evolution of systems; and techniques to manage shared complex structured data objects in larger heterogeneous, distributed information systems. Intelligent systems technology focuses on advanced techniques for knowledge representation, reasoning, and machine learning to enable computer understanding of spoken and written language and to advance methods for planning, scheduling, and resource allocation. Human-computer interaction technology focuses on design methods and enabling technology for more natural interaction between people and computers. Microelectronic science calibrates fundamental concepts to produce reliable, testable, and high performance design. High performance Computing (HPC) science generates concepts and methods for validating and verifying design components, and unique approaches to rapidly develop high performance libraries across multiple HPC architectures. This effort supports the Director of Defense Research and Engineering (DDR&E) thrust area, Technology for Affordability.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0601101E Project Number: CCS-02 Date: September 1993
PE Title: Defense Research Sciences Budget Activity: 1. Technology Base

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program:

- (U) Completed an initial distribution of a prototype persistent object base (POB) to sites using electrical, mechanical and software design tools.
- (U) Application of a shared object base to a concurrent engineering support system for POB completed.
- (U) Proof of correctness for a substantial actual VLSI processor chip for software foundations was completed.
- (U) Demonstrated viability of modular interfaces formalism in software foundations.
- (U) Demonstrated intelligent mechanisms for visualization of information and the usefulness of speech language recognition technology in realistic application domains for interactive problem solving under human computer interface.
- (U) Developed and demonstrated improved mechanisms for rapidly constructing and evolving individual modules; and applied several languages to support architectural definition and prototyping for integrated environments.
- (U) Fully automated machine translation using statistical modeling methods with 70 percent comprehension.
- (U) Developed concepts for language to specify software architecture and interconnection amongst modules in software systems, for component-oriented approaches to large-scale software systems, for reuse of aspects of systems architecture and design, and for active vision and vision-guided navigation.
- (U) Demonstrated close integration of object-oriented database and programming language technologies.
- (U) Developed approaches combining model-based vision with neural networks, and tools that can verify adherence to formalized interface specifications and then demonstrated approaches on standard protocols.
- (U) Demonstrated new fault tolerant interconnection techniques which can be implemented on scalable parallel systems and constructed high performance libraries which allow execution across multiple applications.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0601101E

PE Title: Defense Research Sciences

Project Number: CCS-02

Date: September 1993

Budget Activity: 1. Technology Base

(U) FY 1994 Planned Program:

- (U) Develop benchmark problems, metrics, and test data sets for advanced research in information sciences. (\$2.3M)
- (U) Develop advanced concepts for machine learning, automated reasoning, and knowledge representation for spoken language understanding, written language understanding, and large-scale planning, scheduling, and resource allocation methods. (\$1.7M)
- (U) Explore the utility of advanced information processing methods in spoken language understanding, written language understanding, and automated planning systems. (\$5.8M)
- (U) Develop design concepts for interactive, dialogue-based human computer interaction. (\$4.3M)
- (U) Develop process model approaches for prototyping large-scale software systems. (\$1.0M)
- (U) Develop advanced concepts for software understanding, high assurance, and software system composition. (\$5.2M)
- (U) Develop advanced concepts for heterogeneous, distributed software system architectures and tools to support construction and maintenance of software systems. (\$2.9M)
- (U) Develop design concepts of advanced components needed for highly reliable computing systems including mobile, high performance, and graphical systems. (\$6.1M)
- (U) Develop advanced concepts for high performance libraries to support multiple parallel architectures and integrated with compiler technology. (\$4.3M)

(U) FY 1995 Planned Program:

- (U) Provide internet access to benchmark problems, metrics, and test data sets and conduct experimental evaluations involving multiple intelligent systems and software technologies. (\$2.3M)
- (U) Develop initial prototype of reusable machine learning, automated reasoning, and knowledge representation methods for spoken language understanding, written

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0601101E

PE Title: Defense Research Sciences

Project Number: CCS-02

Date: September 1993

Budget Activity: 1. Technology Base

language understanding, and large-scale planning, scheduling, and resource allocation methods. (\$1.6M)

- (U) Experimentally evaluate advanced information processing methods in spoken language understanding, written language understanding, and automated planning systems. (\$5.9M)
- (U) Develop initial tool kits for interactive, dialogue-based human computer interaction. (\$4.4M)
- (U) Develop initial language-based methods for software understanding, high assurance, and software system composition. (\$4.7M)
- (U) Develop initial prototypes for heterogeneous, distributed software system architectures and tools to support construction and maintenance of advanced intelligent systems. (\$3.8M)
- (U) Experimentally evaluate library research which support multiple parallel architectures. (\$1.9M)

(U) FY 1996 Planned Program:

- (U) Refine and enhance benchmark problems, metrics, and test data sets and conduct experimental evaluations involving multiple intelligent systems and software technologies. (\$2.0M)
- (U) Experimentally evaluate prototype implementations of reusable machine learning, automated reasoning, and knowledge representation methods for spoken language understanding, written language understanding, and large-scale planning, scheduling, and resource allocation methods. (\$2.3M)
- (U) Enhance advanced information processing methods in spoken language understanding, written language understanding and automated planning systems. (\$4.7M)
- (U) Experimentally evaluate tool kits for interactive, dialogue-based human computer interaction. (\$4.2M)
- (U) Experimentally evaluate language-based methods for software understanding, high assurance, and software system composition. (\$5.9M)

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0601101E

PE Title: Defense Research Sciences

Project Number: CCS-02

Date: September 1993

Budget Activity: 1. Technology Base

- (U) Experimentally evaluate prototypes for heterogeneous, distributed software system architectures and tools to support construction and maintenance of advanced intelligent systems. (\$1.3M)

D. (U) WORK PERFORMED BY: University of Southern California, Information Sciences Institute, Marina Del Rey, CA; Stanford University, Palo Alto, CA; Massachusetts Institute of Technology, Cambridge, MA; University of California at Berkeley, CA; Carnegie Mellon University, Pittsburgh, PA; University of Massachusetts at Amherst, Amherst, MA; and Northwestern University, Evanston IL.

E. (U) RELATED ACTIVITIES: The technologies developed in this project provide the foundation for further developments in PE 0602301E, Computing Systems and Communications Technology.

F. (U) OTHER APPROPRIATION FUNDS: None.

G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0601101E Project Number: ES-01 Date: September 1993
 PE Title: Defense Research Sciences Budget Activity: 1. Technology Base

A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1993 Actual	FY 1994 Estimate	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	To Complete	Total Program
ES-01 Electronic Sciences	34,791	31,853	35,073	23,468	24,835	24,560	25,333		Continuing Continuing

B. (U) BRIEF DESCRIPTION OF PROJECT: This project explores and demonstrates electronic and optoelectronic device, circuit, and processing concepts that will provide: (1) new technical options for future electronic and optical systems used in information transmission, gathering and processing; and (2) a substantial increase in performance and cost reduction per function. Research areas include new electronic device and circuit concepts, innovative optical arrayed interconnects and smart pixels, optical memory research, artificial neural network (ANN) research, fundamentally new semiconductor processing, and microelectromechanical systems (MEMS) technology. This basic research project creates the vital new concepts for advanced electronic, optoelectronic, and MEMS components to meet future DoD needs involving all the DDR&E thrust areas.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

- (U) FY 1993 Program:
- (U) Developed diode laser amplifier arrays.
 - (U) Developed coupled, quantum-well optical switches.
 - (U) Demonstrated blue-green diode laser.
 - (U) Fabricated nonlinear polymer device structures with molecular beam epitaxy (MBE).
 - (U) Initiated development of neural network techniques for temporal processing, nonlinear adaptive filters, and synthesis of 3-D images from 2-D views.
 - (U) Demonstrated low cost, long-wavelength infrared focal plane arrays operating at 77°K using low cost Gallium Arsenide (GaAs) substrates.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0601101E

PE Title: Defense Research Sciences

Project Number: ES-01

Date: September 1993

Budget Activity: 1. Technology Base

- (U) Demonstrated feasibility of free-space optical interconnect.
- (U) Developed conformal printing, 3-dimensional machine technologies, and shared multi-project fabrication runs for the manufacturing of microelectromechanical systems (MEMS).
- (U) Determined the utility of indium phosphide (InP) heterojunction bipolar transistor (HBT) technology for very wide bandwidth analog-to-digital (A/D) converter applications.
- (U) Demonstrated quantum dots grown in nanochannel glasses.
- (U) Measured optical constants of III-V materials Gallium Arsenide (GaAs), Indium Phosphide, and their alloys) as a function of temperature and strain.
- (U) Demonstrated nanoelectronic shift register.
- (U) Fabricated lateral resonant-tunneling device.

(U) FY 1994 Planned Program:

- (U) Determine applicability of lattice gas computing architecture to nanoelectronics. (\$1.2M)
- (U) Demonstrate self-assembled molecular wiring of 10 nanometer lengths. (\$.7M)
- (U) Deliver process simulator computer program with two-dimensional capability for GaAs and silicon-based devices. (\$2.0M)
- (U) Demonstrate fabrication of abrupt semiconductor interfaces using limited reaction processing. (\$1.0M)
- (U) Fabricate array of 10 nm channels with 15 nm spacing using nanochannel glass. (\$.5M)
- (U) Demonstrate compressed-size, two-dimensional edge detector using nanoelectronics. (\$1.0M)
- (U) Demonstrate lateral resonant tunneling. (\$1.3M)
- (U) Explore applicability of single electron transistors to ultra-dense logic and memory. (\$1.0M)
- (U) Demonstrate nanometer scale critical dimensions of devices grown on patterned substrates. (\$0.5M)
- (U) Demonstrate 10X reduction in ultra-low-power laser size. (\$2.0M)

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0601101E

PE Title: Defense Research Sciences

Project Number: ES-01

Date: September 1993

Budget Activity: 1. Technology Base

- (U) Demonstrate optical interconnects for chip-to-chip and on-chip. (\$3.0M)
- (U) Develop semiconductor laser diodes with minimum relative intensity noise (RIN) for analog modulation. (\$1.0M)
- (U) Investigate charge transport across quantum well interface for high speed photonic operation. (\$.8M)
- (U) Investigate crystalline and quantum well nonlinear polymer devices. (\$1.0M)
- (U) Develop physics and chemistry-based process and equipment models for process tool control. (\$1.5M)
- (U) Develop real-time control methodologies for critical processes. (\$1.4M)
- (U) Develop dynamic neural networks for temporal processing applications. (\$.7M)
- (U) Design and initiate development of neural network techniques and associated analog network hardware for image preprocessing and feature extraction. (\$2.0M)
- (U) Determine theoretical performance capabilities and limitations of specific neural network architectures. (\$.7M)
- (U) Develop microsensor CAD/CAM and process simulation tools and initiate multi-project, common fabrication infrastructure. (\$8.5M)

(U) FY 1995 Planned Program:

- (U) Develop bright blue LED arrays. (\$1.0M)
- (U) Demonstrate capable smart pixel arrays. (\$1.8M)
- (U) Demonstrate optical interconnect for shared memory application. (\$3.5M)
- (U) Insert lift-off technology into semiconductor module processing. (\$2.0M)
- (U) Develop functional optoelectronic modules. (\$2.4M)
- (U) Develop voltage measurement capability suited to nanoelectronics (better than 100 nanometer spatial resolution and 50GHz temporal resolution). (\$.5M)
- (U) Demonstrate power reduction by a factor of five through the combination of nanoelectronics and conventional devices. (\$.7M)
- (U) Explore compressed circuitry using multi-valued logic and nanoelectronics. (\$2.0M)
- (U) Demonstrate utility of nanochannel glasses in fabricating nanoelectronic structures. (\$5.5M)

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #06011101E

PE Title: Defense Research Sciences

Project Number: ES-01

Date: September 1993

Budget Activity: 1. Technology Base

- (U) Demonstrate improved process control of molecular beam epitaxy (MBE), controlling temperature to within 2 degrees and thickness to within 1 nm. (\$1.5M)
- (U) Demonstrate all-optical read/write of multi-quantum well memory device. (\$1.5M)
- (U) Utilize nanostructures for high resolution electron and ion-beam technology. (\$3.5M)
- (U) Determine optimum materials system for fabricating silicon-based nanoelectronics. (\$2.8M)
- (U) Demonstrate three-terminal lateral resonant tunneling transistor. (\$1.0M)
- (U) Apply dynamic neural networks to speech and handwriting recognition tasks. (\$1.0M)
- (U) Develop and demonstrate prototype analog hardware for image preprocessing and feature extraction. (\$1.5M)
- (U) Develop high-yield, high-uniformity fabrication processes for microelectromechanical system (MEMS) devices and merge MEMS with related fabrication technologies in optics, optoelectronics and microwave devices. Initiate low-bandwidth, large-scale MEMS-based sensor networks. (\$7.8M)

(U) FY 1996 Planned Program:

- (U) Develop visible vertical cavity lasers. (\$2.0M)
- (U) Develop subwavelength light sources. (\$1.0M)
- (U) Demonstrate optical computing applications with smart pixel implementation. (\$3.6M)
- (U) Demonstrate feasibility of magnetic memory with nanometer scale devices. (\$1.5M)
- (U) Demonstrate improved contacts to indium phosphide. (\$0.5M)
- (U) Determine optimum devices and circuit architectures for cellular automata nanoelectronics. (\$1.5M)
- (U) Demonstrate chemical self-assembly of nanoelectronic devices. (\$3.1M)
- (U) Optimize circuit architectures for reduced power and higher noise margin using combined conventional electronics and nanoelectronics. (\$1.8M)
- (U) Develop techniques for incorporating knowledge in neural network systems. (\$0.4M)

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #06011101E

PE Title: Defense Research Sciences

Project Number: ES-01

Date: September 1993

Budget Activity: 1. Technology Base

- (U) Develop structured, hierarchical neural networks for solving complex, multi-dimensional problems (\$0.6M)
- (U) Merge computation, control, and communication with microelectromechanical sensors, actuators, and structures, and integrate into manufacturing processes. Demonstrate microdynamic arrays, hybrid microdynamic, optical and microwave devices. Demonstrate wireless, communication microelectromechanical-based sensor networks. (\$7.5M)

D. (U) WORK PERFORMED BY: Analog Devices, Cambridge, MA; Stanford University, Palo Alto, CA; California Institute of Technology, Pasadena, CA; Texas Instruments, Dallas, TX; University of Michigan, Lansing, MI; University of California at Santa Barbara, CA; Cornell University, Ithaca, NY; Massachusetts Institute of Technology, Cambridge, MA; Yale University, New Haven, CT; Optivision, Palo Alto, CA; Rockwell International Science Center, Thousand Oaks, CA; Naval Research Laboratory, Washington, D.C; and David Sarnoff Research Center, Princeton, NJ.

E. (U) RELATED ACTIVITIES: Efforts in this project are coupled to the Services' program through use of Service agents, annual DoD-wide program reviews, and review by the Advisory Group on Electron Devices (AGED). These activities assure that no unnecessary duplication of effort occurs. This project provides a research base for 0602712E, MPT-02, Electronics Processing Technology.

F. (U) OTHER APPROPRIATION FUNDS: None.

G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0601101E Project Number: MS-01 Date: September 1993
 PE Title: Defense Research Sciences Budget Activity: 1. Technology Base

A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1993 Actual	FY 1994 Estimate	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	To Complete	Total Program
MS-01 Materials Sciences	25,592	14,127	10,856	15,981	18,601	19,762	19,253		Continuing Continuing

B. (U) BRIEF DESCRIPTION OF PROJECT: This project is concerned with the development and exploitation of: biologically-derived materials for use as electron source structures; magnetic composite materials and therapeutic spatial light modulators; biosensors for battlefield trauma care; development of high power/energy density electrochemical power sources (batteries and fuel cells). Other areas of focus are research on the disposal of toxic chemical wastes and waste source reduction for DoD-relevant manufacturing processes; and development of advanced algorithms and associated technologies for detecting and identifying targets hidden in foliage.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program:

- (U) Completed performance testing of solid state batteries previously delivered in FY 1992.
- (U) Initiated contracts for toxic waste source reduction for DoD-relevant manufacturing processes.
- (U) Produced prototype primary solid state battery.
- (U) Initiated construction of pilot plant for safe destruction of toxic military chemical wastes.
- (U) Developed novel methods for automatic target recognition and classification using wavelets, a new signal representation method, and other advanced mathematical techniques.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0601101E
PE Title: Defense Research Sciences

Project Number: MS-01 Date: September 1993
Budget Activity: 1. Technology Base

- (U) Initiated a program to develop elevated temperature operation of laser diodes to pump solid state lasers and two micron laser sources for infrared countermeasures.

(U) FY 1994 Planned Program:

- (U) Electrochemistry (\$7.6M). Develop high energy density/power density electrochemical power sources for a variety of military applications. Utilize supercritical water oxidation to destroy DoD toxic wastes.
 - (U) Demonstrate high efficiency direct oxidation fuel cell power module.
 - (U) Demonstrate prototype rechargeable solid state military battery. Deliver 20 prototypes.
 - (U) Construct supercritical water oxidation (SCWO) processor for destruction of toxic wastes. Demonstrate agent simulant destruction using SCWO technology.
 - (U) Initiate a program to develop a logistic fuel cell for mobile electric power. Evaluate fuel reformer catalysts and processor components.
- (U) Biotechnology (\$5.1M). Utilize biological technologies to enhance various aspects of military medicine.
 - (U) Initiate program in medical technology concerned with developing medical sensors and the use of advanced information technologies to enhance battlefield trauma care.
 - (U) Demonstrate binding affinity, reagent stability, and cellular uptake of oligonucleotide reagents for infections.
- (U) Optical materials (\$1.4M). Develop elevated temperature laser diode arrays.
 - (U) Demonstrate nondestructive read out and selective erasure for holographic data storage.

(U) FY 1995 Planned Program:

- (U) Electrochemistry (\$10.8M). Concentrates on use of logistic fuels (hydro-carbon based) in advanced energy sources (fuel cells).
 - (U) Evaluate novel logistics fuel catalysts, electrolytes and electrodes.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0601101E Project Number: MS-01 Date: September 1993
PE Title: Defense Research Sciences Budget Activity: 1. Technology Base

- (U) Develop logistic fuel cell components and demonstrate near ambient temperature operation.

(U) FY 1996 Planned Program:

- (U) Electrochemistry (\$16.0M). Expand work on logistic fuel cells for military applications.
 - (U) Develop logistic fuel cell processor.
 - (U) Demonstrate required fuel cell performance.
 - (U) Complete logistic fuel processor subsystem tests, and integrate fuel cell stack and processor.
 - (U) Complete design of 2 megavolt (MV) class logistic fuel cell power plant for fixed and bare base deployment.

D. (U) WORK PERFORMED BY: University of Pennsylvania, Philadelphia, PA; Massachusetts Institute of Technology, Cambridge, MA; California Institute of Technology, Pasadena, CA; GA Technologies, La Jolla, CA; International Fuel Cells, South Windsor, CT; Northwestern University, Evanston, IL; and Georgetown University, Washington, DC.

E. (U) RELATED ACTIVITIES: ARPA's research in Materials Sciences and Biotechnology is coordinated within the DoD and with other federal agencies via Office of Science and Technology Policy (OSTP) Committee on Materials (COMAT), and various Director Defense Research and Engineering (DDR&E) sponsored topical workshops on advanced materials and biotechnology. These activities assure that no unnecessary duplication of effort occurs.

F. (U) OTHER APPROPRIATION FUNDS: None.

G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602301E

PE Title: Computing Systems and

Communications Technology

Date: September 1993

Budget Activity: 1. Technology Base

A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1993 Actual	FY 1994 Estimate	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	To Complete	Total Program
ST-01 JASON 1,240	1,240	1,227	1,218	1,203	1,190	1,178		Continuing	Continuing
ST-10* Strategic Computing 68,246	0	0	0	0	0	0	0	0	Transferred to ST-11 and ST-19
ST-11* Intelligent Systems & Software 38,831	68,841	89,798	102,726	115,284	151,034	150,447		Continuing	Continuing
ST-12* Advanced Quantum Electro-Optics and Electronic Warfare 8,653	0	0	0	0	0	0	0	0	Transferred to TT-06
ST-19 High Performance Computing (HPC) 133,107	236,043	241,717	242,191	267,360	264,683	284,774		Continuing	Continuing
ST-20* Distributed Information Systems/C3 34,352	0	0	0	0	0	0	0	0	Transferred to ST-11
ST-21* Software Engineering Institute (SEI) 15,635	0	0	0	0	0	0	0	0	Transferred to ST-22

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602301E
 PE Title: Computing Systems and Communications Technology
 Date: September 1993
 Budget Activity: 1. Technology Base

ST-22*	Software Engineering Technology	19,562	19,205	18,678	20,250	Continuing	Continuing
	21,814 39,096 40,740						
ST-23	Surveillance Research	51,217	60,738	68,402	69,112	Continuing	Continuing
	26,451 21,486 41,316						
TOTAL	348,329 366,706 414,798	416,914	463,790	503,987	525,761		

*These projects reflect the Program Element/Project consolidation and realignment within ARPA.

B. (U) BRIEF DESCRIPTION OF ELEMENT: This program element funds projects directed toward the application of advanced, innovative computing systems and communications technologies. These programs include:

(U) ARPA leadership of the Federal High Performance Computing and Communications Initiative to develop technologies to allow computer systems to function at a trillion operations per second and a billion bits per second networking to ensure availability for future defense needs. This technology will be incorporated into advanced applications to solve critical defense problems such as distributed C3 systems.

(U) The efforts funded in the Intelligent Systems and Software project focus on the development of new information processing technology concepts that lead to fundamentally new software and intelligent system capabilities. Emphases are in autonomous systems, interactive problem solving, source integration, software development, and manufacturing automation and design engineering.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602301E

PE Title: Computing Systems and
Communications Technology

Date: September 1993

Budget Activity: 1. Technology Base

- (U) Software Engineering Institute (SEI) and Software Technology for Adaptable, Reliable Systems (STARS). SEI works to transition, introduce and promulgate modern software in the defense industry. The STARS program develops large-scale software products that have commercial as well as military capabilities.
- (U) The Surveillance Research project efforts in the Verification Readiness Program enhance the U.S. surveillance capabilities for monitoring worldwide nuclear explosions. While the Counter-proliferation Technology Program concentrates on the development of technologies for detecting the production, testing and storage of nuclear materials and weapons. This project will develop and provide demonstrations of advanced technologies that will enable the assessment of counter-proliferation options to neutralize nuclear threats.
- (U) The JASON studies support the national security community.
- (U) The programs contained in Projects ST-11, ST-19 and ST-22 reflect the Department's initiative to support dual-use technologies.

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FY 1995-1996 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602301E
 PE Title: Computing Systems and Communications Technology
 Project Number: ST-01 Date: September 1993
 Budget Activity: 1. Technology Base

A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1993 Actual	FY 1994 Estimate	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	To Complete	Total Program
ST-01	JASON 1,240	1,240	1,227	1,218	1,203	1,190	1,178	Continuing	Continuing

B. (U) BRIEF DESCRIPTION OF PROJECT: This project supports the JASONS, an independent group of distinguished individuals dedicated to sophisticated scientific and technical research and analysis in support of the National Security Community. JASON membership is carefully balanced to provide a wide spectrum of scientific expertise and technical analysis in theoretical and experimental physics, materials, information sciences, and other allied disciplines.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

- (U) FY 1993 Program:
- (U) Conducted extensive technical investigations in areas such as: advanced sensors for surveillance and strike; shallow water acoustic ASW; advanced concepts for lightweight survivable combat vehicles; advanced materials; and signal processing.
- (U) FY 1994 Planned Program:
- (U) Continue investigations in technical problems related to the ARPA mission of supporting the Services with the development of advanced technologies, including new approaches to stealth, surveillance, communications and signal processing.

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FY 1995-1996 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602301E

PE Title: Computing Systems and Communications Technology

Project Number: ST-01

Date: September 1993

Budget Activity: 1. Technology Base

(U) FY 1995 Planned Program:

- (U) Continue investigations involving: structural acoustics; advanced land combat vehicles; precision strike; ASW; nuclear weapon proliferation; and global surveillance and communications.

(U) FY 1996 Planned Program:

- (U) Continue studies in: nuclear and chemical weapons proliferation, precision strike weapons, global surveillance and communications; counter drug surveillance techniques; shallow water ASW; and advanced signal processing.

D. (U) WORK PERFORMED BY: MITRE Corporation, McLean, VA supports the JASON group.

E. (U) RELATED ACTIVITIES: Not applicable.

F. (U) OTHER APPROPRIATION FUNDS: None.

G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FY 1995-1996 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602301E

Project Number: ST-11 Date: September 1993

PE Title: Computing Systems and

Budget Activity: 1. Technology Base

Communications Technology

A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1993 Actual	FY 1994 Estimate	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	To Complete	Total Program
ST-11 Intelligent Systems and Software	38,831	68,841	89,798	102,726	115,284	151,034	150,447	Continuing	Continuing

B. (U) BRIEF DESCRIPTION OF PROJECT: Develop new information processing technology concepts that lead to fundamentally new software and intelligent systems capabilities. This will enable advanced information systems (involving both humans and computers) to more effectively accomplish decision making tasks in stressful, time sensitive situations and create efficient software systems supporting computer and software intensive defense systems. Major areas of technical emphasis are in: (a) intelligent systems (artificial intelligence) including autonomous systems, interactive problem solving and intelligent integration of information from heterogeneous sources; (b) software development technology including languages, algorithms, data and object bases, domain specific software architectures, software prototype technology, software design tools, software reuse, and advanced software engineering environments; and (c) manufacturing automation and design engineering, including the development of advanced software systems which support sharing of engineering knowledge, advanced product and process design representations, integrated product and process design, software tools for design process management, manufacturing process planning, manufacturing process control and demonstrations.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program:

- (U) Demonstrated standards for reuse of knowledge among diverse systems, including Integrated Weapons Systems Databases; developed and validated standards of

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FY 1995-1996 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602301E

PE Title: Computing Systems and
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Project Number: ST-11

Date: September 1993

Budget Activity: 1. Technology Base

- knowledge transmission; and demonstrated standards for knowledge transmission in industrial prototypes.
- (U) Integrated a number of independently developed software development tools to demonstrate the utility of integration mechanisms based on data sharing and message passing; and demonstrated tools to support the test and analysis of real time systems and integrated these tools into a software development environment.
 - (U) Demonstrated robust speech recognition of dictation with 12 percent word error with a 20,000 word vocabulary, in continuous speech, independent of speaker.
 - (U) Released beta version compiler for the image understanding architecture, scalable parallel computer optimized for machine vision applications.
 - (U) Incorporated stereoc vision into complete working autonomous systems; and developed robust systems to aid real time planning of autonomous systems.
 - (U) Deployed configured data sets to R&D community to support research on image understanding, stereo vision, planning, hybrid control, and machine learning.
 - (U) Developed and demonstrated agent based architectures for sharing design knowledge, manufacturing process planning, and manufacturing control.
 - (U) Developed architecture for a heterogeneous database system which integrates, interfaces, creates and maintains a single database from multiple non-interoperable intelligence community databases.
 - (U) Developed a corresponding machine learning strategy to enable computers to learn specific user interaction characteristics and knowledge based decision aids to support the rapid construction of multiple battle plans.
 - (U) Developed improved message-handling algorithms, databases, evaluation techniques and algorithms for document-image processing and installed text data extraction system for Drug Enforcement Agency (DEA) investigative reports.

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FY 1995-1996 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602301E

PE Title: Computing Systems and
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Project Number: ST-11

Date: September 1993

Budget Activity: 1. Technology Base

(U) FY 1994 Planned Program:

- (U) Develop test case scenarios and internet accessible software testbeds that typify the type of advanced information processing requirements in DoD systems such as autonomous systems, command and control, and manufacturing systems. (\$10.0M)
- (U) Experimentally evaluate the integration of multiple intelligent systems and software technologies in an autonomous vehicle. (\$.9M)
- (U) Release the beta version of the Image Understanding Environment (IUE) and develop advanced methods for vision guided navigation, cartographic modelling, and target detection and identification. (\$15.6M)
- (U) Develop initial capabilities for human-aided machine translation, document understanding, and robust speech understanding in adverse acoustic conditions. (\$12.1M)
- (U) Develop advanced real-time planning and control algorithms. (\$3.8M)
- (U) Develop knowledge-based decision aids to support the rapid construction of crisis action plans. (\$3.8M)
- (U) Develop advanced methods for information fusion, aggregation, summarization, and explanation. (\$3.7M)
- (U) Develop initial language-based methods for describing domain-specific software architecture and tools that facilitate composing a software system based on a domain specific architecture. (\$6.7M)
- (U) Develop initial advanced software environment that supports composition tool integration and software development and testing using animation techniques. (\$3.1M)
- (U) Develop fundamental evaluation and design concepts to support highly distributed, wide bandwidth information processing application that require persistent objects. (\$3.4M)
- (U) Enhance agent based architectures for sharing design knowledge, manufacturing process planning, and manufacturing control. (\$3.2M)
- (U) Integrate persistent object base, case-based reasoning and physics-based simulation models in an integrated product/process design (IPPD) testbed. (\$2.5M)

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Program Element: #0602301E

PE Title: Computing Systems and

Communications Technology

Project Number: ST-11

Date: September 1993

Budget Activity: 1. Technology Base

(U) FY 1995 Planned Program:

- (U) Experimentally evaluate the integration of multiple advanced intelligent systems and software technologies in multiple autonomous vehicles. (\$3.9M)
- (U) Upgrade the Image Understanding Environment (IUE) based on FY 1994 evaluations and develop prototype implementations of advanced methods for vision guided navigation, cartographic modelling, target detection and identification. (\$11.0M)
- (U) Develop initial prototype implementations for human-aided machine translation, document understanding, and robust speech understanding in adverse acoustic conditions. (\$13.0M)
- (U) Develop initial prototype implementations of advanced real-time planning and control algorithms. (\$4.0M)
- (U) Enhance knowledge based decision aids to support the rapid construction of multiple crisis action plans. (\$10.6M)
- (U) Develop concepts and implement prototype of scalable machine intelligent algorithm for autonomous associate and assistant intelligent systems. (\$1.0M)
- (U) Design and prototype a domain specific software architecture for a weapons system crew station associate system. (\$1.0M)
- (U) Develop initial prototype implementations of advanced methods for information fusion, aggregation, summarization, and explanation. (\$5.0M)
- (U) Experimentally evaluate language-based methods for describing domain specific software architecture and tools that facilitate composing a software system based on a domain specific architecture. (\$4.7M)
- (U) Experimentally evaluate advanced software environment that supports composition tool integration and software development and testing using animation techniques. (\$4.0M)
- (U) Develop prototype to support highly distributed, wide bandwidth information processing application that require persistent objects. (\$5.2M)
- (U) Enhance the IPPD testbed to include intelligent product and process representations and a scalable framework to invoke and attach design tools for electro-mechanical systems. (\$3.0M)

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FY 1995-1996 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602301E

PE Title: Computing Systems and

Communications Technology

Project Number: ST-11

Date: September 1993

Budget Activity: 1. Technology Base

- (U) Develop information infrastructure services for manufacturing, including network access to engineering analysis and rapid prototyping services. (\$6.0M)
- (U) Experimentally evaluate agent based architectures for sharing design knowledge, manufacturing process planning, and manufacturing control. (\$7.4M)
- (U) Initiate study measuring the impact of technology aids on teacher, staff, and student performance. Train teachers in use of technology in selected clusters use model school districts (such as Val Verde & Port Hueneme) to transfer high technology concepts of use to other clusters. (\$4.0M)
- (U) Initiate development of a heterogeneous testbed for human computer interaction technology insertion for testing, evaluating and demonstrating. (\$6.0M)

(U) FY 1996 Planned Program:

- (U) Enhance (and use in wide spread community experiments) test case scenarios and internet accessible software testbeds that typify the type of advanced information processing requirements in DoD systems such as autonomous systems, command and control, and manufacturing systems. (\$10.0M)
- (U) Enhance advanced methods for vision guided navigation, cartographic modelling, and target detection and identification and facilitate transition and adoption of the resulting technology. (\$2.0M)
- (U) Experimentally evaluate implementations for human-aided machine translation, document understanding, and robust speech understanding in adverse acoustic conditions. (\$9.0M)
- (U) Experimentally evaluate implementations of advanced real-time planning and control algorithms. (\$3.0M)
- (U) Evaluate knowledge-based decision aids to support the rapid construction of multiple crisis action plans in an operational exercise. (\$7.8M)
- (U) Experimentally evaluate advanced methods for information fusion, aggregation, summarization, and explanation. (\$5.0M)
- (U) Experimentally evaluate scalable machine intelligent methods for machine learning, automated reasoning and real time problem solving. (\$10.0M)

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PE Title: Computing Systems and
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Budget Activity: 1. Technology Base

- (U) Experimentally evaluate weapons system crew associate systems. (\$10.0M)
- (U) Enhance advanced software environment that supports composition tool integration and software development and testing using animation techniques and facilitate transition. (\$3.0M)
- (U) Experimentally evaluate prototype implementations to support highly distributed, wide bandwidth information processing application that require persistent objects. (\$4.0M)
- (U) Enhance agent based architectures to include machine learning techniques and advanced information processing methods to facilitate sharing design knowledge, manufacturing process planning, and manufacturing control. (\$3.9M)
- (U) Demonstrate feasibility of authoring tools in creating domain specific multimedia curriculum in key DoD applications; and virtual labs and learning by simulation approaches in key DoD applications. Architect intelligent layer to integrate and manage education tools in several pilot clusters. Measure student performance with and without technology aids in advanced key DoD applications. (\$5.0M)
- (U) Experimentally evaluate the use of advanced design spreadsheets and integrated tool sets to optimize product and process designs for Advanced Technology Demonstration (ATD) applications. (\$4.0M)
- (U) Expand network design and manufacturing services to include factory simulation and reusable product/process design libraries. (\$8.0M)
- (U) Demonstrate agent-based interconnection of multiple heterogeneous ATD design environments for cooperative use of tools and data. (\$8.0M)
- (U) Continue the human computer interaction heterogeneous testbed product development and insertion. Test, evaluating and demonstrate enhancements to the user community. (\$10.0M)

D. (U) WORK PERFORMED BY: Stanford University, Palo Alto, CA; University of Southern California, Information Sciences Institute, Marina Del Ray, CA; Carnegie Mellon University, Pittsburgh, PA; Harvard University, Cambridge, MA; University of Massachusetts, Amherst, MA; Computational Logic, Inc., Austin, TX; University of California at Berkeley, CA; Teleos Corporation, Palo Alto, CA;

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ISX Corporation, Woodland Hills, CA; General Electric, Schenectady, NY; Martin Marietta, Denver, CO; IBM, Oswego, NY; GTE, Chantilly, VA; Honeywell, Minneapolis, MN; and Rice University, Houston, TX.

E. (U) RELATED ACTIVITIES: Builds upon the new high performance computing technologies being produced under project ST-19 in this program element.

F. (U) OTHER APPROPRIATION FUNDS: None.

G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602301E

Project Number: ST-19 Date: September 1993

PE Title: Computing Systems and

Budget Activity: 1. Technology Base

Communications Technology

A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1993		FY 1994		FY 1995		FY 1996		FY 1997		FY 1998		FY 1999		To		Total Program
	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Complete	Complete	
ST-19																	
High Performance Computing																	
	133,107	236,043		241,717		242,191		267,360		264,683		284,774		Continuing	Continuing		

B. (U) BRIEF DESCRIPTION OF PROJECT: This project develops the computing, networking, and associated software technology base underlying the solutions to computational and information-intensive applications for future Defense and Federal needs. These technologies lead to successive generations of higher performance and widely available systems scalable to a trillion operations per second (teraops) systems and billion bits per second (gigabits) networking, associated software technologies, advanced information infrastructure technology, and prototype experimental applications leading to national-scale efforts across the Federal government. Results will be used in other ARPA and Defense programs for experimental application to critical defense problems.

(U) High Performance Computing (HPC) develops software and hardware technologies leading to a scalable computing and communications technology base for systems configured over a wide performance range, from mobile handheld devices to desktop workstations to the largest-scale, highest performance systems, including embedded versions of these systems. The Scalable Computing Systems component develops, demonstrates, and evaluates for early experimental use a variety of advanced scalable parallel systems at the frontier of computing. The Microsystems component develops design tools, support environments, and infrastructure to support the research and development of advanced scalable parallel computing components and systems for large-scale computing systems, embedded computing systems, and wireless computing systems. Microsystems also supports innovative system prototyping techniques in hardware and software as well as early small-

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PE Title: Computing Systems and Communications Technology
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scale architecture experiments leveraging scalable computing technology, micro-architectures, low-energy components and processes, optimization techniques, and advanced packaging technology. The Scalable Software component develops technologies for operating systems, programming languages, compilers, tools, and environments to enable the effective use of the new high performance computing technologies. The Information Infrastructure Software and Services component develops underlying technologies to support large, complex and distributed applications; such as privacy and trust mechanisms and remote resource sharing. The Information Infrastructure Application and trust mechanisms component develops early prototype experiments of important large-scale, Demonstrated applications in conjunction with various Defense and Federal programs. The distributed applications component develops high performance networking technologies and associated Networking component develops high performance networking technologies and associated capabilities. The Defense Technology Integration and Infrastructure component applies the new computing technologies to solve specific defense problems in innovative ways.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program:

- (U) Demonstrated 100 Gigaops-class systems as part of joint projects including Cray Research (T3D), Intel Corporation (Paragon), Thinking Machines Corporation (CM-5), Kendall Square Research (KSR-1), and International Business Machines (SP-1, SP-2).
- (U) Demonstrated advanced design technologies including semiconductor process representations, electromagnetic modeling tools on the HPC base, and synthesis of heterogeneous multiprocessors and testable circuits.
- (U) Developed and demonstrated low cost rapid prototyping multichip module (MCM) capability.
- (U) Applied packaging and cooling technology in support of 150 gigaflops per cu. ft. embedded Touchstone demonstration.
- (U) Demonstrated prototype scalable microkernel operating systems for systems with thousands of processing nodes that may also include multiple processors, advanced systems services, and concepts for their extension to time-constrained systems.
- (U) Demonstrated prototype transparent replication and end user trusted configuration

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Program Element: #0602301E

PE Title: Computing Systems and
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Budget Activity: 1. Technology Base

- (U) of wide area file system.
- (U) Developed and demonstrated a prototype trusted version of the scalable microkernel operating system (TMach). Developmental evaluation for both U.S. trusted computer security criteria and European harmonized criteria.
- (U) Demonstrated high performance networking in gigabit testbeds and identified limitations for future research.
- (U) Demonstrated asymmetric networking, coupling dial-up telephone and cable television resources.
- (U) Demonstrated prototype all-optical network using wave division multiplexing.

(U) FY 1994 Planned Program:

- Scalable Computing Systems. (\$63.0M)
 - (U) Develop foundations for petaoperations (10¹⁵) per second and terabits systems.
 - (U) Demonstrate software and hardware compatibility between scalable commercial HPC systems and embeddable versions.
 - (U) Demonstrate scalable mass storage systems and associated system services and input/output channels.
 - (U) Develop 10 gigaflops/cu.ft. militarized, embeddable Touchstone system.
- Microsystems. (\$44.0M)
 - (U) Develop and demonstrate semiconductor virtual process design coupled to actual fabrication line for real-time process control.
 - (U) Enhance and move towards commercialization rapid prototyping MCM technology.
 - (U) Fabricate operational sub-micron diameter vertical Field Effect Transistor (FET) for ultra high density read-only memory.
 - (U) Demonstrate 200 Mhz superpipelined processor as part of continuing architectural exploration of high performance GaAs processes.
 - (U) Develop and demonstrate tools and environments to support the design of low power and wireless computing systems.
 - (U) Demonstrate enhanced fabrication services integrated with library management tools and extended system synthesis capabilities.

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Program Element: #0602301E

Project Number: ST-19 Date: September 1993
Budget Activity: 1. Technology Base

PE Title: Computing Systems and
Communications Technology

- Scalable Software. (\$27.8M)
 - (U) Demonstrate scalable libraries for Defense-critical problems, such as computational physics and image processing.
 - (U) Develop and distribute HPC software, documentation, performance measurements, and prototype applications using a wide area file system.
 - (U) Demonstrate distributed ADA on scalable HPC systems.
 - (U) Prototype HPC programming environments for standard languages like C++ and Fortran, while developing new languages like Dataflow and new environments like Visual Programming.
- Information Infrastructure Software and Services. (\$27.0M)
 - (U) Integrate real-time functionality into portable operating system technology.
 - (U) Develop trusted user services for scalable operating systems.
 - (U) Initiate laboratory scale demonstration of privacy support in the operating system for distributed computing systems.
 - (U) Develop prototype file systems capable of having intermittent communications.
- Information Infrastructure Application Demonstrations. (\$4.6M)
 - (U) Demonstrate initial national-level digital library for exchange of technical reports between five major universities, ARPA, and the Library of Congress.
 - (U) Initiate, in conjunction with NSF and NASA, a broader initiative to expand digital library technology in the areas of information indexing, remote access, and storage management.
- Networking. (\$41.3M)
 - (U) Demonstrate C3 systems technology with scalable high performance network technology enabling full multimedia real-time information exchange using early gigabit networks.
 - (U) Demonstrate prototypes of gigabit SONET/ATM technology operating over fiber and satellite media.
 - (U) Perform initial interconnections among gigabit testbeds.
 - (U) Demonstration of all-optical Local Area Networks (LANs).

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602301E

PE Title: Computing Systems and

Communications Technology

Project Number: ST-12 Date: September 1993
Budget Activity: 1. Technology Base

- (U) Demonstrate medical, terrain visualization, and modeling applications on 100 Mbit and Gbit-class networks.
- Defense Applications and Infrastructure. (\$28.3M)
- (U) Develop initial prototype of C3 and weapons systems using embeddable high performance technologies. Demonstrations will have 10 billion operations per second per cubic foot based on 100 billion operations per second systems technologies.

(U) FY 1995 Planned Program:

- Scalable Computing Systems. (\$64.9M)
- (U) Demonstrate teraops-class modules covering major models of scalable computing, spanning shared and distributed memory models and fine and coarse grain parallelism, that have the potential for being the foundation for next generation and cost-effective units in computing systems.
- (U) Develop 50-100 gigaflop/cu. ft. militarized embedded systems leveraging commercial scalable computing components and software.
- (U) Demonstrate advanced technology based scalable units of replication.
- Microsystems. (\$48.7M)
- (U) Extend network-accessible design and fabrication services to include computational prototyping concepts.
- (U) Develop early module-level synthesis capabilities.
- (U) Demonstrate wireless computing design environments through the design of early prototype, high bandwidth, pico cellular, and wireless access points to the wireline infrastructure.
- (U) Continue development and standardization of process representations.
- (U) Demonstrate higher levels of process optimization to include low energy.
- (U) Initial demonstrations of micro-architectures for advanced packaging and scalable units of replication.

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Program Element: #0602301E

Project Number: ST-19 Date: September 1993

Budget Activity: 1. Technology Base

PE Title: Computing Systems and
Communications Technology

- Scalable Software. (\$26.3M)
 - (U) Demonstrate real-time operating system support tools for scalable, distributed HPC systems.
 - (U) Demonstrate software development environments for distributed heterogeneous systems on workstation-based tenth-scale teraops systems.
 - (U) Experimentally characterize input/output requirements for large- and small-scale computing systems on scalable parallel systems.
 - (U) Demonstrate prototype integrated HPC programming environment for Fortran and C++.
 - (U) Develop portable, real-time fault tolerant operating system software which is compatible with embeddable and commercial scalable HPC systems.
- Information Infrastructure Software and Services. (\$32.6M)
 - (U) Prototype distributed search, retrieval, discovery, and registration mechanisms in support of digital libraries.
 - (U) Prototype trusted systems in support of electronic commerce and infrastructure protection, including authentication, audit trail, digital signatures, electronic solicitations and bidding, and electronic contracting.
 - (U) Demonstrate usage metering and performance monitoring on focused infrastructure applications.
- Information Infrastructure Application Demonstrations. (\$4.4M)
 - (U) Select and experimentally characterize focused National Challenge applications testbeds leveraged on high performance network testbeds and major information technologies in high performance computing.
 - (U) Prototype technologies for distributed digital libraries, incorporating techniques for scalable storage management and data repositories, persistent object bases, and multimedia objects.
 - (U) Proof of concept prototype of copyright management system, based on Privacy Enhanced Mail (PEM), which demonstrates fully electronic copyright registration, recordation, rights transfer and management.

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Program Element: #0602301E

PE Title: Computing Systems and

Communications Technology

Project Number: ST-19 Date: September 1993

Budget Activity: 1. Technology Base

- Networking. (\$45.2M)
 - (U) Demonstrate cross-country gigabit and networking technologies coupled with high performance computing capabilities.
 - (U) Demonstrate more advanced Internet capabilities including more diverse bitways, such as cable and wireless links, with embedded intelligence to improve ease of use.
 - (U) Demonstrate techniques for rate-adaptive quality of service negotiation in asymmetric networks.
 - (U) Demonstrate bandwidth and service reservation guarantees for networks in support of real-time and critical services.
- Defense Applications and Infrastructure. (\$19.6M)
 - (U) Develop initial prototype of advanced C3 and weapons systems using advanced embeddable and high performance computing technologies.

(U) FY 1996 Planned Program:

- Scalable Computing Systems. (\$58.3M)
 - (U) Demonstrate foundations for next generation distributed systems with smaller-scale teraops class systems and individual gigaops processors.
 - (U) Demonstrate embedded computing capable of 100 billion operations per second per ft³ and scalable to systems capable of several hundred billion operations per second.
 - (U) Prototype embedded computing system modules with scalability concepts and containing scalable computing, memory hierarchy, and power on a single unit of replication.
- Microsystems. (\$46.9M)
 - (U) Demonstrate initial network-based computational prototyping services.
 - (U) Demonstrate integrated module-level synthesis capability.
 - (U) Demonstrate design environments supporting simulation and synthesis of wireless systems spanning from integrated circuits to network applications.

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Program Element: #0602301E

PE Title: Computing Systems and

Communications Technology

Project Number: ST-19 Date: September 1993
Budget Activity: 1. Technology Base

- (U) Demonstration of fault tolerant and reliable components of large-scale HPC systems
- Scalable Software. (\$28.8M)
 - (U) Demonstrate integrated HPC programming environment for Fortran and C++.
 - (U) Develop second generation of scalable, portable libraries.
 - (U) Laboratory-scale demonstration of seamless integration of real-time, replication, and limited fault tolerance in OS via modular capabilities for range of computing application from desktop to largest scalable heterogeneous systems.
- (U) Demonstrate integrated compiler and operating systems services supporting multiple resources.
- Information Infrastructure Software and Services. (\$42.1M)
 - (U) Demonstrate extended toolkits to prototype intuitive, user and application-customizable interfaces.
 - (U) Develop a prototype environment for wide area collaborative work, providing long-term persistent object repositories, and supporting virtual reality and remote presence.
 - (U) Develop and demonstrate new service extensions based on previously developed service architectures and standards.
- Information Infrastructure Application Demonstrations. (\$4.7M)
 - (U) Demonstrate first generation experiments based on selected modest-scale National Challenge application testbeds.
 - (U) Develop a prototype market for information and services as a "proof of concept" testbed for advanced electronic commerce and digital libraries, including experimental recharge mechanisms.
 - (U) Develop universal, widely available, multimedia, privacy-enhanced electronic mail to drive the development of the underlying service layers.
 - (U) Deploy electronic copyright management system to Library of Congress.

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Program Element: #0602301E

Project Number: ST-19 Date: September 1993

PE Title: Computing Systems and

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Communications Technology

- Networking. (\$45.3M)
 - (U) Prototype networks at 10-100 Gbit speed using optical technologies and verify scalable network protocols.
 - (U) Demonstrate national/international scale extensions of existing architecture including nomadic computing.
 - (U) Demonstrate naive user application to access Internet technologies and systems without a terminal interface.
 - (U) Develop a scalable, heterogeneous computing prototype based on proxy and distributed network computing services as a first step towards distributed metacomputing.
- Defense Applications and Infrastructure. (\$16.1M)
 - (U) Demonstrate advanced Defense-specific functionality by incorporating real-time voice, video, and simultaneous processing of information intensive computing.
 - (U) Provide experimental testbed services employing advanced high performance computing technologies for Defense users.

D. (U) WORK PERFORMED BY: Massachusetts Institute of Technology, Cambridge, MA; Intel Corp, Hillsboro, OR; Carnegie Mellon University, Pittsburgh, PA; Thinking Machines, Cambridge, MA; Maden Tech, Arlington, VA; University of California, Berkeley, Berkeley, CA; Cray Research, Chippewa Falls, WI; and University of Southern California, Information Sciences Institute, Los Angeles, CA.

E. (U) RELATED ACTIVITIES: Program Element (PE) #0602301E, Project ST-11, Intelligent Systems and Software and PE 0603739E, Project MT-04, Electronic Module Technology.

F. (U) OTHER APPROPRIATION FUNDS: None.

G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FY 1995-1996 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602301E

PE Title: Computing Systems and

Communications Technology

Project Number: ST-22

Date: September 1993

Budget Activity: 1. Technology Base

A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1993		FY 1994		FY 1995		FY 1996		FY 1997		FY 1998		FY 1999		Total	
	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Complete	Program
ST-22																
Software Engineering Technology																
21,814	39,096	40,740	19,562	19,205	18,678	20,250	Continuing	Continuing								
(*15,635)																

*As part of a consolidation Project ST-21 (SEI) was transferred to this project. Prior year funds are shown for continuity purposes.

B. (U) BRIEF DESCRIPTION OF PROJECT: Software technology is a top item on the DoD Key Technologies list because of continually increasing demands for quality software in DoD software-intensive systems, and the need for an advanced state of software engineering practice in their production. This project funds the Software Engineering Institute (SEI) and the Software Technology for Adaptable, Reliable Systems (STARS) program.

(U) The SEI is a Federally Funded Research and Development Center (FFRDC) established in 1984 to conduct programs in software engineering. The SEI is composed of world class software engineers whose efforts are directed at transitioning technology and the acceptance of modern software engineering techniques and methods, promulgating their use throughout the defense industry, and establishing standards of excellence for the software engineering profession.

(U) The STARS program is a technology development, integration and transition program to demonstrate a process driven, domain specific, reuse-based approach to software engineering that is supported by appropriate tool and environment technology. STARS is generating three key integrating elements toward a family of large-scale "software factory" products: a set of Software Engineering Environments (SEEs); a set of modern tailorable software life-cycle process building blocks; and a software asset library capability to facilitate software productivity.

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PE Title: Computing Systems and
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Project Number: ST-22

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Budget Activity: 1. Technology Base

The SEEs will be composed of commercially-supported products with open interfaces to stimulate the Computer Aided Software Engineering (CASE) tools marketplace. The SEEs will reinforce use of modern process models, have seamless interfaces to asset libraries, and will be evaluated on current DoD programs. SEI and STARS efforts are aimed at enabling future DoD software intensive weapon systems to meet mission requirements quickly and affordably.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program:

- (U) Completed STARS SEE initial operational capability.
- (U) Continue development of STARS process asset library.
- (U) Tailored STARS SEEs, asset libraries, and process building blocks for use on Service demonstrations.
- (U) Evaluated and extended STARS software asset library capabilities and plan for its transition to become self-supporting.
- (U) Developed prototype STARS software development plan 2000.
- (U) Developed risk management approach and course.
- (U) Initiated integration of capability Maturity Model, Software Process Assessment, and Software Capability Evaluation instruments.
- (U) Transitioned Rate Monotonic Analysis (RMA) training to commercial vendors.
- (U) Began integrating RMA and "analytic redundancy theory" to provide improved fault tolerance.
- (U) Developed courses and tools to support security incident handling on the Internet.

(U) FY 1994 Planned Program:

- (U) Participate with and support Services in STARS demonstration projects. (\$7.5)
- (U) Publish demo project lessons learned reports, jointly with Services. (\$.5M)
- (U) Refine STARS concepts, processes, methods, tools based on demonstration projects results. (\$6.2M)

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FY 1995-1996 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602301E Project Number: ST-22 Date: September 1993
PE Title: Computing Systems and Budget Activity: 1. Technology Base
Communications Technology

- (U) Continue development and integration efforts in process and reuse technology. (\$2.1M)
- (U) Operate and enhance ASSET capabilities. (\$2.0M)
- (U) Refine technology transition strategies, continue support for TT affiliates program. (\$2.7M)
- (U) Continue commercialization initiatives. (\$3M)
- (U) Refine and extend software development plan 2000. (\$7M)
- (U) Produce updated Software Process Assessment and Software Capability Evaluation instruments. (\$4.6M)
- (U) Document architecture studies in Guidebook for Real-Time Air Vehicle simulators. (\$4.7M)
- (U) Develop/conduct Risk Identification Training Course. (\$4.1M)
- (U) Begin development of a "Technology Maturity Model" and "Human Resources Maturity Model". (\$3.6M)

(U) FY 1995 Planned Program:

- (U) Continue support to Services in STARS demonstration projects. (\$6.7M)
- (U) Software architectures and application code developed using STARS Technologies on demo projects in testing and evaluation. (\$5.7M)
- (U) Executive level megaprogramming briefing and support material. (\$5M)
- (U) Final STARS concepts, processes, methods, tools based on demonstration projects results. (\$4.0M)
- (U) Refine technology transition strategies, continue support for TT affiliates program. (\$1.7M)
- (U) Continue commercialization initiatives. (\$6M)
- (U) Software development plan 2000 available for wide-spread use. (\$5M)
- (U) Operate and enhance ASSET capabilities. (\$2M)
- (U) Develop initial version of "Process Value Method" for determining anticipated business value of a process change. (\$2M)
- (U) Develop Risk Evaluation training course. (\$2M)

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FY 1995-1996 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0602301E

PE Title: Computing Systems and
Communications Technology

Project Number: ST-22

Date: September 1993

Budget Activity: 1. Technology Base

- (U) Produce guides to best model-based software engineering practice (\$6M); to best reengineering practice (\$5M); and an Open Systems Architecture Handbook. (\$4M)

(U) FY 1996 Planned Program:

- (U) Develop Capability Maturity Model (CMM) version 2. (\$4.6M)
- (U) Initiate CMM Validation and tailoring of CMM for small organizations. (\$3.0M)
- (U) Prepare Software Risk Capability Improvement Guide. (\$3.0M)
- (U) Develop Guide to Best Practice in system understanding. (\$5.0M)
- (U) Develop Open Systems Standard for High Performance Networks. (\$4.0M)

D. (U) WORK PERFORMED BY: The SEI is a Federally Funded Research and Development Center. The contractor is Carnegie Mellon University, Pittsburgh, PA. The STARS prime contractors are Boeing Aerospace Corporation, Kent, WA; IBM Federal Systems Company, Gaithersburg, MD; and Paramax, McLean, Va.

E. (U) RELATED ACTIVITIES:

- (U) 0602301E, Intelligent Systems and Software (ST-11).
- (U) 0601101E, Information Sciences (CCS-02).
- (U) 0603756D, Consolidated DoD Software Initiative (Ada Program).
- (U) 0604740F, Computer Resource Management Technology.

(U) The ARPA PE activities above are managed to ensure that there is no duplication of effort among programs. ARPA ensures that SEI and STARS commonalities are synergetic by supporting a joint STARS/SEI team to work on process element definitions.

F. (U) OTHER APPROPRIATION FUNDS: None.

G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602301E
 PE Title: Computing Systems and Communications Technology
 Project Number: ST-23 Date: September 1993
 Budget Activity: 1. Technology Base

A. (U) RESOURCES: (\$ In Thousands)

Project Number Title	FY 1993		FY 1994		FY 1995		FY 1996		FY 1997		FY 1998		FY 1999		Total
	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Program Complete
ST-23															
Surveillance Research															
	26,451	21,486	41,316	51,217	60,738	68,402	69,112	Continuing	Continuing						

B. (U) BRIEF DESCRIPTION OF PROJECT: This multifaceted research project is divided into two interrelated parts: (1) a Comprehensive Test Ban (CTB) Verification Readiness Program to enhance U.S. surveillance capabilities for monitoring worldwide nuclear explosions, and (2) a Counter-proliferation Technology Program to develop technologies for detecting the production, testing and storage of nuclear materials and weapons. Legislative and administrative policy is to complete negotiations of an internationally verifiable CTB by 1996, with a demonstration of a prototype international verification system in 1995. This project provides the research and development to prepare the verification arrangements which will be needed to negotiate and implement this treaty.

(U) As part of the CTB Readiness Program, this project provides the required technical support for U.S. participation in nuclear test ban treaty negotiations in the Conference on Disarmament and for the associated development and testing of an International Monitoring System. The advanced surveillance technologies developed are incorporated into existing operational nuclear monitoring systems. The proliferation of weapons of mass destruction and their associated delivery systems constitute the major threat to U.S. armed forces and allies in the Post-Cold War security environment. The objective of the counter-proliferation effort is to develop new technologies and enhance existing technology to support detection, monitoring, and interdiction of the proliferation of nuclear, chemical, biological, and advanced conventional weapons. This project addresses methods for demonstrating technologies to enhance the monitoring of the Nuclear Non-Proliferation Treaty and its renewal. The project will develop and provide early

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602301E

PE Title: Computing Systems and

Communications Technology

Project Number: ST-23

Date: September 1993

Budget Activity: 1. Technology Base

demonstration of advanced sensors, information processing, modeling, and response option technologies to enable the warning, capability assessment and tailored counterproliferation options that are required to effectively detect and neutralize these threats. This effort is critically needed to provide decision-makers with vastly increased flexibility in dealing with potential adversaries acquiring weapons of mass destruction capabilities.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program:

- (U) Nuclear Test Monitoring
 - (U) Provided technical support to Comprehensive Test Ban (CTB) deliberations, including those in the Conference on Disarmament and began testing of a prototype international CTB seismic monitoring system.
 - (U) Developed key elements of the U.S. CTB verification readiness program.
 - (U) Began transfer of technology of advanced seismic arrays and Intelligent Monitoring System to the U.S. Atomic Energy Detection System.
 - (U) Completed Yield Estimation System and transferred to U.S. Atomic Energy Detection System.
 - (U) Developed multivariate statistical analysis framework for seismic event discrimination.
 - (U) Developed an advanced low-cost experimental seismic array for deployment and testing in the Mideast.
 - (U) Tested a new Threshold Monitoring (TM) concept on the Russian test site at Novaya Zemlya.
- (U) Counter Proliferation Monitoring
 - (U) Began program for advanced nuclear materials sensor systems, including: high-resolution; room-temperature radiation devices; high-efficiency xenon detectors; and scintillating fiberoptics.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602301E

PE Title: Computing Systems and

Communications Technology

Project Number: ST-23

Date: September 1993

Budget Activity: 1. Technology Base

- (U) Began the development of laboratory nanoscale particle analysis techniques for improved forensic assay and interpretation of nuclear samples.
- (U) Began development and demonstration of the components of a global non-proliferation monitoring system and automated effluent monitoring, including deployment of an initial prototype at a site near Iran.
- (U) Began a development program for the detection and identification of the first test of potential proliferating countries, including the use of miniaturized electronics and optimized configurations.

(U) FY 1994 Planned Program:

- (U) U.S. CTB Verification Readiness Program. (\$15.7M)
 - (U) Provide technical support to nuclear testing deliberations, including those between the five nuclear powers and within the Conference on Disarmament.
 - (U) Continue development and testing of the prototype, international Comprehensive Test Ban (CTB) monitoring system, incorporating multisensors and advanced signal processing technologies in an international data center.
 - (U) Implement technologies for global nuclear threshold monitoring with focus on areas of concern in the Middle East and North Korea.
 - (U) Develop advanced techniques for the automated identification of small seismic events.
 - (U) Develop and test techniques for automated knowledge acquisition in Mid-east and other areas where U.S. has little previous experience.
 - (U) Explore machine learning, machine discovery and new visualization technologies to automate seismic data processing.
 - (U) Continue the transfer of advanced signal processing technologies into the operational systems.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602301E

Project Number: ST-23 Date: September 1993

PE Title: Computing Systems and

Budget Activity: L. Technology Base

Communications Technology

- (U) Counter Proliferation Program. (\$5.8M)
 - (U) Incorporate into the global nonproliferation monitoring system the initial prototype of advanced particle and air sampling system and deploy into the Middle East area for testing and evaluation.
 - (U) Test first advanced methods on improved laboratory nanoscale particle analysis techniques.
 - (U) Continue development of high-resolution, room temperature, radiation sensors into lightweight systems for monitoring and inspections.
- (U) FY 1995 Planned Program:
 - (U) U.S. Comprehensive Test Ban (CTB) Verification Readiness Program. (\$15.9M)
 - (U) Provide technical support to nuclear test ban negotiations, including within the Conference on Disarmament.
 - (U) Conduct full-scale testing of the prototype international CTB monitoring system.
 - (U) Demonstrate automated knowledge acquisition capability with focus on Mid-east.
 - (U) Incorporate automated identification techniques and demonstrate capability with a focus on events in the Middle East.
 - (U) Incorporate automated data processing techniques into and test with CTB global seismic monitoring system.
 - (U) Counter Proliferation Program. (\$25.4M)
 - (U) Provide technical support to nuclear proliferation deliberations.
 - (U) Demonstrate the operation of particle and air sampling monitoring systems as portions of an open global nuclear proliferation monitoring system.
 - (U) Demonstrate laboratory nanoscale particle analysis techniques.
 - (U) Demonstrate prototype operation of high-resolution room temperature radiation sensors.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602301E

Project Number: ST-23 Date: September 1993

PE Title: Computing Systems and

Budget Activity: 1. Technology Base

Communications Technology

- (U) Begin integration of radiation monitoring devices and other sensors into internettted unattended sensors and design concepts of operation for detection and/or area denial.
- (U) Develop advanced technologies for application of microelectromechanical systems for applications in nonproliferation monitoring roles.
- (U) Specify, define and correlate sensor, processing and response option requirements and relevant technology state-of-the-art to identify technology gaps.
- (U) Focus and enhance on-going sensor, information processing, processor and response option development projects to address counterproliferation technology gaps including auto correlation of open source data with classified information to detect and classify early acquisition development and explore policy planning aids.
- (U) Design nuclear and chemical weapon modeling and monitoring systems which include: advanced sensors; process open source and intelligence data to perform correlation based on nuclear and chemical weapons production vulnerability models; and output activity status and collection recommendations.

(U) FY 1996 Planned Program:

- (U) U.S. Comprehensive Test Ban (CTB) Verification Readiness Program. (\$16.6M)
- (U) Provide technical support to nuclear test ban treaty negotiations, including those between the five nuclear powers and within the Conference on Disarmament.
- (U) Integrate automated data processing and event identification technologies into IMS and test on large data set.
- (U) Demonstrate capabilities of global CTB monitoring system.
- (U) Transfer technology to USAEDS and international CTB verification system.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602301E

PE Title: Computing Systems and
Communications Technology

Project Number: ST-23

Date: September 1993

Budget Activity: 1. Technology Base

- (U) Counter Proliferation Program. (\$34.6M)
 - (U) Provide technical support to nuclear proliferation deliberations.
 - (U) Demonstrate radiation sensors in internetted unattended ground sensors and microelectromechanical systems.
 - (U) Develop and test new technologies for radiation sensing devices as stand-alone systems for overt or covert operation.
 - (U) Demonstrate and evaluate projects focussing on-going technologies on sensor development, information processing, response option requirements and systems architectures.
 - (U) Conduct proof-of-concept demonstrations and continue to develop high payoff technology areas, e.g., exotic weapons, internetted radiation and chemical sensors and policy option planning aids.
 - (U) Initiate development of nuclear and chemical weapon modeling and monitoring systems and design extension to biological weapons.
 - (U) Design a system/subsystem perspective demonstration which integrates on-going technology with performance of the demonstration in FY 1997.

D. (U) WORK PERFORMED BY: Major performers include: Teledyne Geotech, Garland, TX; Science Applications International Corporation, San Diego, CA; Southern Methodist University, Dallas, TX; California Institute of Technology, Pasadena, CA; Constellation Technologies, Inc, St. Petersburg, FL; Hughes Santa Barbara Research Center, Santa Barbara, CA; and Grumman Aerospace Corp, Bethpage, NY. Major contracts for new efforts will be competed.

E. (U) RELATED ACTIVITIES: Complementary research is conducted by the National Laboratories of the Department of Energy and by the Air Force Technical Applications Center for operational applications. Close coordination of the program is carried out with the CIA Non-Proliferation Center. The counter proliferation technology effort will build on developments of the Joint DoD Advanced Technology Demonstrations for Global Surveillance and Communications and Precision Strike Thrust Areas, utilizing the technology specifically developed for the WAR BREAKER Program (PE#0603226E, Project Number EE-40).

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602301E

PE Title: Computing Systems and
Communications Technology

Project Number: ST-23

Date: September 1993

Budget Activity: 1. Technology Base

F. (U) OTHER APPROPRIATION FUNDS: None.

G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Agreements with Norway, the Federal Republic of Germany, China, and the Russian Federation call for joint activities in facilities within those countries. The United Nations' Conference on Disarmament, with U.S. concurrence has formally agreed on the development of an international monitoring system and large scale tests of this system and agreements have been made with a large number of countries, including Russia, China, Egypt, and Pakistan to support this effort.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602702E Date: September 1993
 PE Title: Tactical Technology Budget Activity: 1. Technology Base

A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1993 Actual	FY 1994 Estimate	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	To Complete	Total Program
TT-03 Naval Warfare Technology 33,154	33,828	39,883	38,728	39,211	43,396	45,107	Continuing	Continuing	
TT-04 Close Combat Technology 4,686	28,300	22,444	10,210	20,230	28,154	56,549	Continuing	Continuing	
TT-05 Advanced Targeting Technology 14,663	48,098	36,348	29,876	30,518	34,791	35,597	Continuing	Continuing	
TT-06 Advanced Tactical Technology 19,369	*26,285	34,908	27,142	36,143	47,680	57,871	Continuing	Continuing	
TT-07 Aeronautics Technology 25,250	*7,380	0	0	0	0	0	0	127,975	
	97,122	143,391	133,583	105,956	126,102	154,021	195,124		

* TT-07 consolidated with TT-06 in FY 1995-99.

B. (U) BRIEF DESCRIPTION OF ELEMENT: This program element supports the advancement of concepts and technologies to enhance the next generation of tactical systems. The FY 1995 Tactical Technology program funds a number of projects in the areas of Naval Warfare, Close Combat, Advanced Targeting, and Advanced Tactical technology.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602702E
PE Title: Tactical Technology

Date: September 1993

Budget Activity: 1. Technology Base

(U) The Naval Warfare Technology Project is focusing on three areas: command, control, communications, and intelligence (C3I)/synthetic environment; ship system automation; and simulation based design. The C3I/synthetic environment project will create a multi-user maritime network to provide an accurate planning and simulation capability that will improve training, readiness, and operations planning. The Ship Systems Automation project is developing a highly integrated sensor, weapons control, and battle damage suite to reduce costly shipboard manning requirements. Finally, the Simulation Based Design program will provide the tools required to integrate cost, performance, and manufacturing considerations throughout the design process.

(U) Close Combat Technologies projects include the Battlefield management, light contingency vehicle development, and survivability enhancement programs. The Battlefield Management and Simulation project will examine battlefield information and communications requirements through multi-level command and control simulation to improve situational awareness and contingency force responsiveness. The highly mobile armored light contingency vehicle will improve the deployability and capability of the rapid response force. Battlefield survivability issues will be addressed in the Integrated Survivability program, whose focus extends beyond traditional armor improvements to include signature reduction and active countermeasures.

(U) The principal program within the Advanced Targeting Technology project is WAR BREAKER, a program that will enable successful prosecution of time-critical fixed and mobile targets such as theater ballistic missiles, mobile command posts, and tanks. WAR BREAKER is developing the advanced sensor and processing technologies necessary to detect, identify, and counter current and future high value targets.

(U) Finally, the Advanced Technology project is exploring the application of compact lasers, microwave radiation and advanced mathematical algorithms to enhance the performance of radars, sensors, communications, and electronic warfare systems. The technologies under development will improve infrared countermeasures, enable active infrared suppression, permit faster signal processing, improve target recognition, and create smaller, more capable microwave devices.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602702E Project Number: TT-03 Date: September 1993
 PE Title: Tactical Technology Budget Activity: 1. Technology Base

A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1993 Actual	FY 1994 Estimate	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	To Complete	Total Program
TT-03 Naval Warfare Technology	33,154	33,828	39,883	38,728	39,211	43,396	45,107		Continuing, Continuing

B. (U) BRIEF DESCRIPTION OF PROJECT: The Naval Warfare Technology project develops advanced technologies for application to a broad range of naval requirements. The enabling technologies include: Command, Control, Communications, and Intelligence (C3I)/Synthetic Environments for Littoral Warfare; integrated ship sensor, weapons and platform technologies to demonstrate the feasibility of automation for reduced ship manning; advanced design processes based on virtual prototyping and advanced modeling; and technologies to support naval special warfare and ship self defense.

(U) The Command, Control, Communication and Intelligence (C3I)/Synthetic Environment (SE) effort will develop information and communications technologies in support of the information management and planning functions inherent in Commander in Chief (CINC) Command Centers ashore and mobile Joint Task Force (JTF) Command Centers ashore, afloat, and airborne. The technology components will incorporate inter-netted simulation capability for collaborative planning between the CINC, the Commander Joint Task Force (CJTF) and individual units, and will create a Maritime Synthetic Theater of War (MSTOW) for improving training, readiness, and operations planning and rehearsal of the maritime component of U.S. forces.

(U) The Ship Systems Automation (SSA) effort will develop and demonstrate advanced, highly automated sensor, weapons control, and platform (including damage control) systems for submarine and surface ship applications. Through evolving sequential demonstrations of the technologies and their interactions, the effort will show how an integrated system could achieve a significant reduction in crew size. Because personnel account for about 25% of ship life cycle costs, such a

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602702E

PE Title: Tactical Technology

Project Number: TT-03

Date: September 1993

Budget Activity: 1. Technology Base

reduction would lead to immediate and long term cost savings for ship acquisition programs. Technology developments include intelligent command-level decision support components, sensor integration work stations to fuse multi-source data and intelligently display the tactical situation on a tactical situation assessment system, cooperating expert systems conducting mission-context/sensor employment planning, and integrated internal conditions sensor and control systems to intelligently display and control ship physical conditions on a ship's internal assessment system.

(U) The Simulation Based Design (SBD) effort will provide the technological tools necessary to advance ship, as well as other complex mechanical systems, design processes. It will demonstrate a revolutionary design process that will permit manufacturing, cost, performance, and life cycle considerations to be coordinated and integrated throughout the entire process, from concept development to manufacture and operation. The system will provide digital mockups through advanced visualization methods to serve as the link between the designers and the computer aided design (CAD) and physics-based engineering analysis models that form the basic structure of the process. Further, these mockups will provide significant design process cost savings through the elimination of expensive, inefficient wooden mockups and physical models.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program:

- (U) Demonstrated optimization of resource allocation with the Acoustic Warfare Battle Management Decision Support System for Fleet commander.
- (U) Demonstrated Anti-Submarine Warfare (ASW) passive acoustic multi-sensor fusion using real-time data.
- (U) Prepared concept design for Ship Systems Automation (SSA) program.
- (U) Designed Simulation-Based Design (SBD) system architectures and operating system modules.
- (U) Initial SBD feasibility demonstration conducted; demonstrated virtual environment as an input/output device to Computer-Aided Design (CAD), preliminary connectivity, seamless integration of multiple CAD representations, "ripple

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602702E

PE Title: Tactical Technology

Project Number: TT-03

Date: September 1993

Budget Activity: 1. Technology Base

effect" of design modifications, simulated manufacturing sequence, and simulated life cycle activities.

(U) FY 1994 Planned Program:

- (U) Demonstrate full fidelity acoustic synthetic ocean environment simulation capability. (\$3.2M)
- (U) Initiate development of employment, deployment and execution aids for CINC command complex. (\$5.9M)
- (U) Develop system architecture concept and initiate detailed design for Ship Systems Automation (SSA). (\$3.2M)
- (U) Conduct initial laboratory demonstration of SSA concept. (\$10.6M)
- (U) Second SBD feasibility demonstration; real-time interaction in virtual environment. (\$2.3M)
- (U) Complete antiship missile defense technology study. (\$0.5M)
- (U) Final SBD feasibility demonstration; seamlessly integrate component production from design through manufacture. (\$3.1M)
- (U) Initiate SBD enabling technology demonstration development programs. (\$5.0M)

(U) FY 1995 Planned Program:

- (U) Demonstrate initial Command, Control, Communication and Intelligence/Synthetic Environment (C3I/SE) mission planner at a CINC command complex. (\$7.0M)
- (U) Expand acoustic synthetic ocean development to include electromagnetic environment. (\$2.3M)
- (U) Conduct land based functional demonstrations of Ship Systems Automation (SSA) tactical scene and platform internal assessment technologies. (\$8.1M)
- (U) Conduct initial laboratory demonstration of SSA interactive component technologies. (\$5.8M)
- (U) Complete SBD prototype initial development and complete detail design. (\$8.6M)
- (U) Interim demonstrations of critical SBD technology development status. (\$7.1M)
- (U) Complete study of naval special warfare technology concepts. (\$1.0M)

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602702E

PE Title: Tactical Technology

Project Number: TT-03

Date: September 1993

Budget Activity: 1. Technology Base

(U) FY 1996 Planned Program:

- (U) Demonstrate C3I/SE collaborative planning (CINC to Commander Joint Task Force (CJTF)) in conjunction with WAR BREAKER demonstration. (\$6.3M)
- (U) Demonstrate full spectrum Maritime Synthetic Theater of War (MSTOW) in an advanced demonstration. (\$2.1M)
- (U) Conduct land-based Navy laboratory simulation/stimulation demonstration of SSA interactive component technologies. (\$9.1M)
- (U) Advanced SSA algorithm and integration verification in coordination with Navy laboratories. (\$5.3M)
- (U) Interim SBD prototype demonstration integrating critical technologies. (\$15.9M)

D. (U) WORK PERFORMED BY: AT&T Bell Laboratories, Whippany, NJ; Charles Stark Draper Laboratories, Cambridge, MA and Arlington, VA; Science Applications International Corporation, McLean, VA; Naval Surface Warfare Center, Dahlgren, VA and Carderock, MD; Alliant TechSystems, Arlington, VA; Lockheed Missiles & Space Co., Palo Alto, CA; and General Dynamics, Electric Boat Division, Groton, CT.

E. (U) RELATED ACTIVITIES: To ensure that there is no duplication of effort, this program is coordinated with the Office of Naval Research, Space and Naval Warfare Systems Command, and Naval Sea Systems Command. Related efforts are as follows:

- (U) Program Element #0602314N; Undersea Surveillance & Weapons Technology
- (U) Program Element #0602232N; Command, Control, Communications, and Intelligence (C3I) Technology
- (U) Program Element #0603555N; Enhanced Advanced Technology Demonstration (ATD) (Shallow Water Technology)
- (U) Program Element #0603747N; Advanced Anti-Submarine Warfare (ASW) Technology

F. (U) OTHER APPROPRIATION FUNDS: None.

G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602702E
 PE Title: Tactical Technology
 Project Number: TT-04 Date: September 1993
 Budget Activity: 1. Technology Base

A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1993 Actual	FY 1994 Estimate	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	To Complete	Total Program
TT-04									
Close Combat Technology									
4,686	28,300	22,444	10,210	20,230	28,154	56,549			Continuing Continuing

B. (U) BRIEF DESCRIPTION OF PROJECT: This project is intended to develop technologies for contingency and early entry missions to make U.S. combat forces more deployable, effective, survivable, and affordable; and to create automated design software tools for making systems acquisitions cost effective and responsive. This project supports three main efforts: Battle Management Studies and Simulation; Integrated Survivability; and Integrated Product and Process Development Simulation.

(U) The Battle Management and Simulation program focuses on concept and technology development for improving the situation awareness and response options of contingency forces at all levels of command. This effort will address the information needs and response options of the entire land forces chain of command in the context of joint contingency operations. A simple, multi-level flexible command/control simulation will be developed that is linked to a combat simulation. This will be used to determine the relative effectiveness of various system-level trades. This project will assess the potential to leverage commercial communications to enhance data flow and communications. This will be used as the basis for improved weapon allocation and fire control responsiveness. Novel application software will be developed to assist commanders at multiple levels and enhance joint and coalition operations. The Battle Management project supports the Battle Command Initiative (BCI) in PE 0603226E, Project EE-21 by performing technology base research on novel BCI concepts and supports advanced simulation in project EE-37 by providing the first order simulation upon which the distributed simulation will be based.

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Program Element: #0602702E
PE Title: Tactical Technology
Project Number: TT-04 Date: September 1993
Budget Activity: 1. Technology Base

(U) Battlefield survivability has often been equated with thicker and heavier armor. However, modern weapon lethality and the increased need for deployability require different approaches. The Integrated Survivability program is developing novel technologies to address all aspects of survivability, including detection avoidance (reduced signature), hit avoidance (active countermeasures), and finally, kill avoidance (advanced armors). Hit avoidance and armor are addressed in this program element.

(U) The goal of Integrated Product and Process Development Simulation (IPPD Sim) is to determine system design tradeoffs before advanced development, when 80% of the life cycle costs are fixed. Traditional military systems are designed principally for high performance. IPPD Sim will provide an automated mean for designing systems with producibility and provides estimates of life cycle cost issues, such as supportability and environmental impact. IPPD Sim will support the iteration of feeding system implications back to the user community for resolution during the design phase, reconciling those operational requirements with system producibility, and equating those requirements to a projected life cycle cost, assuring affordability of the system to be produced.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

- (U) FY 1993 Program:
- (U) TRC engine: Improvements in air management fuel injection and combustion analysis provided highest horsepower output to date from monocylinder test rig.
 - (U) Test anti-helicopter mine form/fit systems.
 - (U) Perform concept refinement for Land Warrior use of commercial communication devices.
 - (U) Initiate studies and technologies for advanced battle command systems.
- (U) FY 1994 Planned Program:
- (U) Conduct studies and simulation of multi-level joint battle management information needs and technical approaches to address them. (\$2.1M)

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602702E Project Number: TT-04 Date: September 1993
PE Title: Tactical Technology Budget Activity: 1. Technology Base

- (U) Continue exploration of commercial communications leveraging opportunities. Conduct brassboard test of applicability to dismounted/mounted operations. Examine near-term sensor/response options for countering snipers. (\$4.0M)
 - (U) Conduct simulation and demonstrations of networking for anti-helicopter mines. Transition to Army. (\$2.0M)
 - (U) Evaluate preliminary Light Contingency Vehicle testbed configuration tradeoffs using simulations and begin detailed design. (\$6.8M)
 - (U) Complete hardware experiments of Turbo-Roto Compound engine and transition technology to industry. (\$3.9M)
 - (U) Begin risk-reduction phase of the Small Low Cost Intercept Device (SLID) program. (\$6.0M)
 - (U) Develop and demonstrate selected simulation-based design tools required to simultaneously address performance and producibility of new weapons concepts. Define concept for integrated system of design workstations. (\$3.1M)
 - (U) Complete testing of armor concepts. (\$0.4M)
- (U) FY 1995 Planned Program:
- (U) Develop integrated, multi-level simulation of candidate Battlefield Management information/response systems. (\$4.0M)
 - (U) Develop software for the commander to assess status and tactical options and for multi-lingual message understanding of advanced battle management systems. (\$5.0M)
 - (U) Continue Phase I (risk reduction) efforts in the SLID program. (\$8.0M)
 - (U) Develop simulation toolbox for affordable Integrated Product and Process Design of advanced systems. Demonstrate integrated design workstation. (\$5.4M)
- (U) FY 1996 Planned Program:
- (U) Downselect SLID contractors and proceed with Phase II (testbed development and demonstration) based on best technical and economic approaches. (\$10.2M)

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602702E
PE Title: Tactical Technology

Project Number: TT-04 Date: September 1993
Budget Activity: 1. Technology Base

(U) Program to Completion:

- (U) Develop and demonstrate responsive flexible low-cost precision strike fire control technologies and systems.
- (U) Demonstrate the Small Low Cost Intercept Device (SLID) program to affordably and reliably protect high value assets at standoff. Demonstrate capability to neutralize missiles and protect light vehicles, radars and mobile headquarters.
- (U) Demonstrate a comprehensive capability to relate user performance requirements from product design through producibility, deployability, supportability, reliability, environmental impact and life cycle cost.

D. (U) WORK PERFORMED BY: The major performers include Hughes Aircraft, El Segundo, CA; Raytheon, Lexington, MA; Detroit Diesel Corporation, Detroit, MI; Textron Defense, Wilmington, MA; Lawrence Livermore Laboratories, Livermore, CA; University of Iowa, Iowa City, IA; Texas Instruments, Dallas, TX; TRW, Redondo Beach, CA; Allied Signal, Towson, MD; and Rockwell International, Duluth, GA.

E. (U) RELATED ACTIVITIES: LCV development is being supported by the Army in PE 0603005A, Combat Vehicle and Automotive Advanced Technology, and by the USMC in PE 0602131M, Marine Corps Landing Force Technology, as part of a coordinated joint effort.

F. (U) OTHER APPROPRIATION FUNDS: None

G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: U.S.-ARPA Advanced Armor Protection Program (AAPS). This Program was initiated in FY90 and will run through first quarter of FY 1995. The AAPS program focuses on roof armors, grill armors and new material armors.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602702E
 PE Title: Tactical Technology
 Project Number: TT-05
 Date: September 1993
 Budget Activity: 1. Technology Base

A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1993 Actual	FY 1994 Estimate	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	To Complete	Total Program
TT-05 Advanced Targeting Technology (WAR BREAKER)	14,663	48,098	36,348	29,876	30,518	34,791	35,597	Continuing	Continuing

B. (U) BRIEF DESCRIPTION OF PROJECT: Prosecution of time-critical fixed and mobile targets has long been a concern of the Services as evidenced by past efforts in the areas of Strategic Relocatable Targets and Smart Weapons. Recent experience in Desert Storm has dramatically demonstrated our current inability to prosecute these targets, particularly Tactical Ballistic Missiles (TBMs). The WAR BREAKER program will develop advanced technology and systems to enable the detection, identification and prosecution of a wide range of high value, time-critical fixed and mobile targets including TBMs, mobile command posts, tanks and artillery. This project develops advanced sensor and processing technologies including advanced automatic target recognition, sensor processing, sensor fusion, data fusion, image understanding, text understanding and sensor component technologies. Emphasis is on technology that can perform effective search and strike against existing and future targets, specifically, time-critical fixed and mobile targets. This project will also emphasize technologies enabling a direct connectivity between sensors and shooters to ensure rapid prosecution against fleeting targets.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

- (U) FY 1993 Program:
- (U) Demonstrated feasibility of Command/Control connectivity to support rapid sensor to shooter target data flow.
 - (U) Evaluated advanced radar and electro-optic/infrared (EO/IR) system concepts for focused surveillance applications.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602702E Project Number: TT-05 Date: September 1993
PE Title: Tactical Technology Budget Activity: 1. Technology Base

- (U) Acquired test data to assess target detectability in foliage using an ultra wideband High Frequency (HF)/Ultra High Frequency (UHF) synthetic aperture radar (SAR) system.
- (U) Continued unattended ground sensor algorithm communications development.

(U) FY 1994 Planned Program:

- (U) Continue Damocles proof-of-principle technology development and begin experiment. (\$8.6M)
- (U) Analyze and assess the performance of algorithms in detecting man-made targets in foliage from imaging radar and ultra-wideband (UWB) SAR data. (\$12.7M)
- (U) Acquire and analyze data to assess potential discriminants for detecting and identifying targets in deep clutter. (\$8.7M)
- (U) Initiate Unattended Ground Sensor (UGS) brass board development. (\$5.0M)
- (U) Commence Imagery Exploitation System (IES) Cycle 3 development to incorporate a new imagery sensor type, reduce processing speed and focus on specific theaters. (\$5.4M)
- (U) Conduct exclusive field evaluation of CARABAS and the SRI Ultra-Wideband Synthetic Aperture Radar. (\$4.0M)
- (U) Continue automatic target detection/recognition (ATD/R) technology development supporting prosecution of deep hide targets. (\$3.6M)

(U) FY 1995 Planned Program:

- (U) Complete software development and integration of the Imagery Exploitation System and conduct demonstration and test and evaluation of automatic processing of three sensors to detect and classify units. (\$2.9M)
- (U) Complete evaluation of CARABAS HF and SRI UHF ultra-wideband Synthetic Aperture Radars. (\$2.1M)
- (U) Continue evaluation of enabling technologies for internettted unattended ground sensors (IUGS) brassboards. (\$4.4M)
- (U) Continue software reconfiguration for hybrid parallel automatic target detection/recognition (ATD/R) signal processor. (\$3.0M)

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602702E
PE Title: Tactical Technology

Project Number: TT-05 Date: September 1993
Budget Activity: 1. Technology Base

- (U) Continue data analysis and assessment of the performance of advanced algorithms for detecting targets in foliage from high resolution HF/UHF ultra-wideband SAR data. (\$13.7M)
- (U) Continue ATD/R initiatives and evaluations with universities and industry. (\$5.3M)
- (U) Complete DAMOCLES freeflight demonstrations and concept assessment. (\$5.0M)

(U) FY 1996 Planned Program:

- (U) Continue IUGS brassboard fabrication, integration and laboratory testing. (\$9.6M)
- (U) Complete software reconfiguration for hybrid parallel ATD/R signal processor. (\$1.2M)
- (U) Continue ATD/R initiatives and evaluations with universities and industry. (\$7.8M)
- (U) Continue data analysis and assessment of the performance of advanced algorithms for detecting targets in foliage from high resolution HF/UHF ultra-wideband SAR data. (\$11.3M)

D. (U) WORK PERFORMED BY: General Dynamics, Convair Division, San Diego, CA; Martin Marietta, Orlando, FL; ERIM, Ann Arbor, MI; Lincoln Laboratory, Lexington, MA; Texas Instruments, Dallas, TX; BDM International, McLean, VA; SAIC International, Arlington, VA; Boeing Corp., Seattle, WA; Toyon Research Corporation, Goleta, CA; Naval Command, Control and Ocean Surveillance Center (RDT&E Division), San Diego, CA; US Army Missile Command, Redstone Arsenal, AL; Rockwell International, Anaheim, CA; SRI International, Menlo Park, CA; Loral Systems, Phoenix, AZ; and others to be determined.

E. (U) RELATED ACTIVITIES:

- (U) PE#0603226E, Project EE-40, WAR BREAKER (Critical Mobile Targets) Program is directly dependent on technologies developed in this project.
- (U) This project is a part of the ARPA contribution to the DOD Advanced Technology Demonstrations with the Global Surveillance and Communications and Precision Strike Thrust Areas. The specific projects have been coordinated and fully

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602702E Project Number: TT-05 Date: September 1993
PE Title: Tactical Technology Budget Activity: 1. Technology Base

integrated with Army, Navy and Air Force plans to insure nonduplication and compatibility with the integrated demonstrations planned.

F. (U) OTHER APPROPRIATION FUNDS: None.

G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602702E
 PE Title: Tactical Technology
 Project Number: TT-06 Date: September 1993
 Budget Activity: 1. Technology Base

A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1993 Actual	FY 1994 Estimate	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	To Complete	Total Program
TT-06	Advanced Tactical Technology 19,369	*26,285	34,908	27,142	36,143	47,680	57,871	Continuing	Continuing

*Increases in FY 1994/95 due to merger of ST-12 and TT-07 into TT-06.

B. (U) BRIEF DESCRIPTION OF PROJECT: This project focuses on the technology and applications of compact lasers, microwave radiation sources, and mathematical algorithms for signal processing to dramatically improve the performance of radars, sensors, and systems for electronic warfare and communications. Five broad technology areas are being investigated: (a) compact, efficient, frequency-agile, diode-pumped, solid-state lasers for infrared countermeasure, laser radars and sensors; (b) compact holographic data storage for high bandwidth image processing; (c) high performance, pulsed radio frequency (RF) radiation sources for smaller and better microwave tubes; (d) fast computational algorithms for signal processing, target recognition, electro-magnetic and acoustic propagation in nonlinear medium; and (e) active infrared signature suppression to counter the predominate air-to-air missile threats.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

- (U) FY 1993 Program:
- (U) Demonstrated field transportable brassboard/lasers operating at high average power in the visible and mid-infrared spectral regions.
 - (U) Initiated a program for adaptive pointing and tracking of targets for countermeasures applications.
 - (U) Demonstrated microcathode operation at 1 GHz modulation and 5 ampere per square centimeter emission.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602702E
PE Title: Tactical Technology
Project Number: TT-06 Date: September 1993
Budget Activity: 1. Technology Base

- (U) Designed and fabricated on-board, off-board electronic countermeasure signal processor and generator.
- (U) Began design of an electronic system to demonstrate cooperative angle jamming technique.
- (U) Began design of a 2 Watt, 44 GHz quasi optical millimeter wave power amplifier.

(U) FY 1994 Planned Program:

- (U) Compact Laser (\$5.9M): Perform technology demonstration of power laser operation at one micron; semiconductor diodes for laser pumping; and active target acquisition for infrared countermeasure and laser radars.
- (U) Demonstrate one kilowatt average power one micrometer wavelength laser with output at 10 joule/100 Hz, 10 nanosecond pulse length.
- (U) Demonstrate new semiconductor laser diodes operating at 808 nanometer wavelength.
- (U) Demonstrate wavefront aberration corrections for active pointing and tracking.
- (U) Demonstrate design concepts for high repetition rate infrared countermeasure laser.
- (U) Holographic Data Storage (\$2.5M): Demonstrate new hologram fixing and multiplexing techniques for holographic data storage system.
- (U) Pulsed RF (\$10.1M): Design and fabricate advanced RF radiation sources for radar and RF countermeasure.
- (U) Design and fabricate electronic system to demonstrate cooperative angle jamming technique.
- (U) Design and fabricate 44 GHz solid state, high efficiency amplifiers for space applications.
- (U) Design microwave power tube using microcathode to operate at 10 GHz.
- (U) Demonstrate high performance 94 GHz amplifier operation and begin prototype design.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602702E
PE Title: Tactical Technology
Project Number: TT-06 Date: September 1993
Budget Activity: 1. Technology Base

- (U) Fast Computational Algorithms (\$7.8M): Begin to develop novel algorithms for automatic detection and recognition of difficult-to-find objects.
 - (U) Develop wavelet-based multi-resolution methods and design tools for new digital filters.
 - (U) Demonstrate wavelet methods for detection of transient signals in sonar systems and for multisensor fusion.
 - (U) Demonstrate robust methods for direction finding and interference reduction in airborne platforms.
 - (U) Develop code for fast computation of electromagnetic scattering.
- (U) FY 1995 Planned Program:
 - (U) Compact Laser (\$5.0M): Demonstrate breadboard systems of compact high power lasers, laser diodes and active target acquisition for infrared countermeasure and laser radars.
 - (U) Demonstrate transportable breadboard one kilowatt average power one micrometer wavelength laser with output at 10 joule 100 Hz, 10 nanosecond pulse length.
 - (U) Demonstrate active pointing and tracking breadboard system.
 - (U) Demonstrate breadboard infrared countermeasure laser with wavelength diversity.
 - (U) Holographic Data Storage (\$7.0M): Technology demonstration of page-format and high density input and readout capability.
 - (U) Demonstrate spatial light modulatory and change coupled devices for one million pixel size page storage and readout for holographic data storage.
 - (U) Demonstrate 100 billion bit holographic data storage.
 - (U) Pulsed Radio Frequency (RF) (\$7.5M): Continue fabrication and integration of advanced RF amplifiers and power combining techniques.
 - (U) Fabricate distributed amplifier using microcathode operating at 10 GHz.
 - (U) Fabricate prototype high performance 94 GHz power amplifier.
 - (U) Demonstrate high efficiency power combining technique of solid state devices operating at 44 GHz.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602702E
PE Title: Tactical Technology
Project Number: TT-06 Date: September 1993
Budget Activity: 1. Technology Base

- (U) Fast Computational Algorithms (\$12.6M): Continue development of novel algorithms for automatic target detection, materials and microelectronics processing.
 - (U) Develop and test novel wavelet-based algorithms and tools for digital processor and filters.
 - (U) Develop methods for multiresolution synthetic aperture radar and adaptive waveform design.
 - (U) Apply wavelet design tools to tactical communications and target recognition.
 - (U) Demonstrate fast multipole radar cross section code for order of magnitude increase in capability.
 - (U) Develop simulation tools, signal processing and modern control methods for in-situ sensing and real-time control of materials and microelectronics processing.
 - (U) Develop optimal phase-shift mask design methods.
- (U) Advanced Infrared Signature Suppression (\$2.8M): Demonstrate infrared signature suppression for aircrafts against long range ground-based threats.
- (U) FY 1996 Planned Program:
 - (U) Compact Laser (\$7.0M): Integrate compact lasers with pointing and tracking and demonstrate high efficiency laser diode array.
 - (U) Demonstrate active pointing and tracking system at the laboratory breadboard level integrated with countermeasure lasers.
 - (U) Demonstrate wavelength diverse infrared countermeasure lasers.
 - (U) Demonstrate 1.9 micrometer laser diode arrays for pump solid state lasers.
 - (U) Holographic Data Storage (\$6.0M): Develop 100 billion bit, low noise, breadboard storage system with error correction capability.
 - (U) Demonstrate breadboard 100 billion bit holographic data storage system.
 - (U) Demonstrate signal-to-noise greater than one thousand for data read out and establish error correction schemes.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602702E
PE Title: Tactical Technology

Project Number: TT-06 Date: September 1993
Budget Activity: 1. Technology Base

- (U) Pulsed RF (\$4.5M): Demonstrate high efficiency, high power RF amplifier operations and fabricate adaptive antenna.
- (U) Fabricate and demonstrate reconfigurable antenna operation.
- (U) Demonstrate distributed amplifier at 10 GHz.
- (U) Demonstrate prototype high performance 94 GHz power amplifier.
- (U) Fast Computational Algorithms (\$5.7M): Continue development of novel algorithms for automatic detection and recognition of difficult-to-find objects; perform full-scale test and validation.
- (U) Integrate and validate wavelet-based signal processing algorithms with image understanding and classification algorithms.
- (U) Complete development of methods for optimal waveform design and multi-resolution synthetic aperture radar.
- (U) Demonstrate multi-resolution radar and novel waveforms.
- (U) Advanced Infrared Signature Suppression (\$3.9M): Demonstrate robust infrared treatment compatible with low radar cross-section treatment for aircrafts.

D. (U) WORK PERFORMED BY: Major performers include: Hughes Aircraft Company, El Segundo, CA; Science Research Laboratory, Somerville, MA; TRW, Redondo Beach, CA; Lockheed/Sanders, Nashua, NH; Varian Associates, Palo Alto, CA; Honeywell, Bloomington, MN; Northrop Corporation, Hawthorn, CA; Northrop, Pico Rivera, CA; and McDonnell Douglas, St Louis, MO.

E. (U) RELATED ACTIVITIES: All programs are coordinated with Services' R&D programs to promote technology transfer and avoid duplication of effort.

F. (U) OTHER APPROPRIATION FUNDS: None.

G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Advanced Research Projects Agency (ARPA) is also an active participant in the US-UK Information Exchange Program on laser technology and effects.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602708E

Project Number: IC-03 Date: September 1993

PE Title: Integrated Command and Control Technology

Budget Activity: 1. Technology Base

A. (U) RESOURCES: (\$ In Thousands)

Project Title: High Definition Systems (HDS)

Popular Name	FY 1993 Actual	FY 1994 Estimate	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	To Complete	Total Program
IC-03	152,180	57,214	50,000	50,000	50,000	65,464	50,000	Continuing	Continuing

B. (U) BRIEF DESCRIPTION OF PROJECT: This project develops the technology and manufacturing capability for high definition displays and is important for virtually all DoD applications that involve visual and graphic information. Major components of this program include: projection, head mounted and direct view displays based on multiple technologies; display architectures and processors; compression algorithms; and high speed data transmission. These efforts will establish a domestic technical capability and demonstrate the manufacturing capability of components necessary for military systems that capture, process, store, distribute and display high resolution images.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program:

- (U) Initiated active matrix liquid crystal display (AMLCD) Pilot Demonstration Facility.
- (U) Initiated National Center for Advanced Information Components Manufacturing (NCAICM).
- (U) Delivered 2.3 million pixel 3-light valve digital micromirror projection display.
- (U) Demonstrated 6.3 million pixel active matrix liquid crystal display (AMLCD).
- (U) Initiated U.S. Display Consortium.
- (U) Established Phosphor Technology Center of Excellence.
- (U) Demonstrated high resolution 22" flat tension mask CRT.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602708E

PE Title: Integrated Command and Control Technology

Project Number: IC-03

Date: September 1993

Budget Activity: 1. Technology Base

- (U) Demonstrated stereo camera and stereo hard copy printer.
- (U) Developed new low voltage phosphors for field emission displays.
- (U) Established cost projections for color thin film electroluminescent (TFEL) pilot line.
- (U) Demonstrated 3" monochrome flat CRT.
- (U) Demonstrated proof-of-concept 3-D autostereoscopic display.
- (U) Designed large area high performance microlithography tool.
- (U) Fabricated thin film transistors and displays using rapid thermal system.
- (U) Developed large area plasma deposition processes for liquid crystal display manufacturing.

(U) FY 1994 Planned Program:

- (U) Continue development of flat panel and projection displays for aircraft cockpit, shipboard and mobile computing and communications applications. (\$17.0M)
- (U) Continue development of enabling technology critical to high projection display performance. (\$14.7M)
- (U) Develop U.S. display industry infrastructure and help foster new domestic display business by reducing business risk and dependence on foreign suppliers. (\$8.0M)
- (U) Develop improved phosphor materials and deposition processes for emissive displays (electroluminescent, field emission and plasma displays), and train people in phosphor technology. (\$7.0M)
- (U) Develop imaging systems and processes needed to realize high information throughput. (\$10.5M)

(U) FY 1995 Planned Program:

- (U) Continue development of flat panel and projection displays for aircraft cockpit applications, mobile computing displays, and shipboard and landbased command and control centers. (\$16.0M)
- (U) Continue enabling material and component technologies for performance and cost goals for liquid crystal materials, polymer electroluminescent materials, light

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602708E

PE Title: Integrated Command and Control Technology

Project Number: IC-03

Date: September 1993

Budget Activity: 1. Technology Base

- weight optics, polarizers, color filters, flat backlights, projection lamps, field emitter materials and structures, and phosphors. (\$10.0M)
- (U) Develop manufacturing equipment and processes for the affordable production of high definition displays. Flat panel display manufacturing equipment will be scaled up to handle larger substrates at higher throughputs with improved process capability. (\$12.0M)
- (U) Design and fabricate radio-based communications modules and components. (\$8.0M)
- (U) Develop displays with integrated computation and image processing. (\$4.0M)

(U) FY 1996 Planned Program:

- (U) Continue development of flat panel and projection displays for aircraft cockpit applications, mobile computing displays, and shipboard and land-based command and control center. (\$24.0M)
- (U) Continue development of enabling technology critical to high definition display performance. (\$10.0M)
- (U) Continue systems and processor technology to develop high throughput imaging systems. (\$6.0M)
- (U) Continue development of displays with integrated computation and image processing. (\$10.0M)

D. (U) WORK PERFORMED BY: The major performers are: Xerox Corporation, Palo Alto, CA; Magnascreen Corporation, Pittsburgh, PA; Photon Dynamics, Inc., San Jose, CA; XMR, Inc., Santa Clara, CA; Texas Instruments, Dallas, TX; MRS Technology, Inc., Chelmsford, MA; Planar Systems, Beaverton, OR; Sarnoff Research Center, Princeton, NJ; Zenith Corporation, Chicago, IL; Silicon Video, Cupertino, CA; Micron Display, Boise, ID; and Optical Imaging Systems, Troy, MI.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602708E

PE Title: Integrated Command and Control
Technology

Project Number: IC-03

Date: September 1993

Budget Activity: 1. Technology Base

E. (U) RELATED ACTIVITIES: This project is coordinated with the advanced display technology being developed by the Army Electronics Devices and Technology Laboratory and the Air Force Aircraft Cockpit Integration Directorate and Manufacturing Technology (MANTECH) Directorate at Wright Laboratory. There is no unnecessary duplication within DoD.

F. (U) OTHER APPROPRIATION FUNDS: None.

G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602712E Date: September 1993
 PE Title: Materials and Electronics Technology Budget Activity: 1. Technology Base

A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1993 Actual	FY 1994 Estimate	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	To Complete	Total Program
MPT-01 Materials Processing Technology	73,684	81,047	110,197	109,058	128,620	143,565	154,108	Continuing	Continuing
MPT-02 Electronics Processing Technology	37,202	80,489	105,929	101,797	104,298	104,252	116,453	Continuing	Continuing
MPT-03 Optoelectronics/GaAs	36,877	0	0	0	0	0	0	0	74,037
MPT-04 Advanced Lithography	71,162	0	0	0	0	0	0	0	236,823
MPT-06 High Temperature Superconductivity (HTSC)	35,461	37,788	14,238	10,000	0	0	0	0	97,687
MPT-07 Military Medical/Trauma Care Technology	0	0	26,016	30,000	28,002	20,998	0	0	105,016
TOTAL	254,386	199,324	256,380	250,855	261,550	268,815	270,561	Continuing	Continuing

B. (U) BRIEF DESCRIPTION OF ELEMENT: The objective of this program element is to develop technology related to those materials and devices that make possible a wide range of new military and commercial capabilities. Many of the programs contained in this Program Element reflect the Department's initiative to support dual-use technologies.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602712E

PE Title: Materials and Electronics Technology

Date: September 1993

Budget Activity: 1. Technology Base

(U) The Materials Processing project (MPT-01) concentrates on the development of novel materials, processing techniques, and fabrication strategies for production of more efficient advanced structural and electronic materials manufactured at a lower cost. It includes research on biosensors for chemical surveillance, research on composite materials, synthesis of diamond films, high temperature semiconductor, insertion of ceramics into military system components, flexible solid freeform manufacturing, and toxic waste elimination.

(U) The Electronics Processing project (MPT-02) develops advanced electronic and optoelectronic devices, semiconductor process tools and methodologies, and materials for infrared devices. Areas of emphasis include high-performance analog-to-digital converters, military optical processors, novel optoelectronic devices, artificial neural network technology, low power electronics and semiconductor process design and synthesis.

(U) The High Temperature Superconductivity project (MPT-06) materials have reached a stage of development when specific applications have been identified in thin-film electronic devices and circuitry for military avionics with concomitant benefit to commercial electronics.

(U) Military Medical/Trauma Care Technology project (MPT-07) is an initiative to significantly improve battlefield trauma care. The Advanced Biomedical Technology portion focuses on the human factors of advanced technology concepts in a front-line battlefield environment through development of body-worn monitors, field-portable digital imaging equipment, and battlefield surgical simulators. The Health Care Information segment concentrates on development of physician, medic, and community information associates for utilization by both medics during combat care scenarios and physicians during patient visits.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602712E

PE Title: Materials and Electronics Technology

Project Number: MPT-01

Budget Activity: 1. Technology Base

Date: September 1993

A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1993 Actual	FY 1994 Estimate	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	To Complete	Total Program
MPT-01	73,684	81,047	110,197	109,058	128,620	143,565	154,108		Continuing Continuing

B. (U) BRIEF DESCRIPTION OF PROJECT: The major goals of this project are to develop novel materials, processing techniques, and fabrication strategies for production of advanced structural and electronic materials with improved performance and at lower manufacturing costs. A major area of concentration is the application of process modeling, sensors, and advanced control to materials manufacturing and flexible fabrication and assembly. Other predominant areas include: biosensors for chemical surveillance and digital imaging systems for battlefield trauma care; research on composites (metal matrix, polymer matrix, ceramic matrix, carbon-carbon and microlaminates) for advanced aerospace structural materials to upgrade gas turbine engine and airframe components. Additional areas of focus are synthesis of diamond films for thermal management in electronic packaging; plasma packaging for microelectronics materials; high temperature semiconductor, such as silicon carbide for high power applications in aircraft and electric vehicles; insertion of state-of-the-art ceramics into military system components (bearings, gas turbine engine components); precision machining of high strength alloys, composites and ceramics using laser and electron beam energy sources, flexible energy delivery systems, and process diagnostic tools. Flexible solid freeform manufacturing capabilities are being developed for high performance structural materials which will fabricate functional components directly from Computer Aided Design (CAD) files and not require part-specific tooling or operator intervention. Environmental research includes DoD related toxic waste elimination and "green" manufacturing which seeks to eliminate or minimize toxic waste produced by manufacturing of products relevant to the DoD.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602712E

PE Title: Materials and Electronics
Technology

Project Number: MPT-01

Date: September 1993

Budget Activity: 1. Technology Base

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program:

- (U) Demonstrated thermal management capability of high conductivity diamond films in an electronic package.
- (U) Demonstrated 3-fold increase in diamond deposition rate by chemical vapor deposition (0.3 grams/hour).
- (U) Provided 6-layer interconnect multi-chip module (MCM) manufacturing unit and program plan to improve module yields to make diamond MCMs cost effective.
- (U) Developed alternative high throughput arrays for robotic screening of computer-designed military therapeutics (computer-screening of lead compounds).
- (U) Demonstrated increased biosensor sensitivity and dynamic range by regulation of genetically transferred cell surface receptors.
- (U) Demonstrated a 5-fold increase in mean time between failures of ceramic hybrid bearings in air cycle machines used on jet aircraft.
- (U) Constructed first order computational process model and rapid densification equipment scale-up design to manufacture low cost carbon-carbon composites.
- (U) Demonstrated, in laboratory tests, the potential for a 30% improvement in accuracy of a heat-seeking missile through the use of ceramic hybrid bearings in the infrared (IR) seeker.
- (U) Demonstrated the fabrication of fibrous monolithic ceramics which combine the low cost component fabrication characteristics of monolithic ceramics with the damage tolerant characteristics of Ceramic Matrix Composites (CMCs).
- (U) Demonstrated production of low oxygen content, polymer derived silicon carbide fibers with strengths of one gigapascal up to 3000°F.
- (U) Manufactured 1800 ft of 1-inch and 1250 ft of 6-inch wide, continuous fiber, metal matrix composite monotape. Produced 25 pounds of titanium matrix composites for gas turbine engine nozzle actuator links.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #06027112E

PE Title: Materials and Electronics Technology

Project Number: MPT-01

Date: September 1993

Budget Activity: 1. Technology Base

(U) FY 1994 Planned Program:

- (U) Biotechnology (\$7.9M): Utilizes biological technologies to develop sensors and imaging systems for battlefield trauma care.
 - (U) Evaluate duration/magnitude of immune response to ultrasonically altered infectious organisms. Initiate development of portable digital x-ray imaging system for battlefield trauma care.
 - (U) Optimize fluidics subsystem, optimize dynamic range for cell-based biosensor.
- (U) High Temperature Structural Materials (\$22.8M): Develop and demonstrate in components affordable structural materials (composites, ceramics, alloys) for jet engines, airframes, missiles and other DoD systems.
 - (U) Investigate preliminary on-line sensing concepts for composite density during direct conversion of liquid hydrocarbon to pyrolytic carbon composite matrix; incorporate reaction chemistry into computational process model.
 - (U) Demonstrate the upgrade potential of the MIA2 tank dual-axis head mirror assembly with silicon carbide mirrors which replace nickel-coated beryllium metal and thereby improve durability while decreasing environmental liabilities.
 - (U) Initiate program on manufacturing of silicon carbide fiber reinforced titanium alloys for components in aircraft gas turbine engines.
- (U) Material and Device Manufacturing (\$12.8M): Fabricate functional prototype components directly from Computer Aided Design (CAD) files. Reduce cost of final machining and assembly of composites and other structures. Develop processing technologies for manufacturing multi-chip modules.
 - (U) Demonstrate solid freeform fabrication machine capability to produce engine quality silicon nitride components with mechanical properties comparable to those manufactured by conventional methods.
 - (U) Develop concepts of flexible manufacturing to actively correct machine error using adaptive materials and demonstrate in a machine.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602712E

PE Title: Materials and Electronics
Technology

Project Number: MPT-01

Date: September 1993

Budget Activity: 1. Technology Base

- (U) Demonstrate aberration correction in fiber optic for continuous wave (CW) and pulsed lasers at 1.06 micron wavelength.
- (U) Identify large format manufacturing materials and critical unit processes and initiate materials, equipment development for multi-chip module (MCM) manufacturing.
- (U) Advanced Materials and Processing (\$18.9): Reduce processing cost of advanced composites, electronic/photonics materials, and smart materials/structures. Incorporate simulation, modeling and intelligent processing of materials concepts.
 - (U) Initiate program in high temperature, high power semiconductors for aircraft and electric vehicle applications.
 - (U) Initiate program to model and simulate complex material microstructures, alloy solidification processes, and photolithographic processes.
 - (U) Develop theoretical models to predict mechanical properties of compositionally modulated multilayer structural composites.
 - (U) Develop intelligent processing production of materials for smart structures.
 - (U) Develop smart materials mechanics theories.
- (U) Batteries (\$6.3M): Improve energy density of military batteries.
 - (U) Initiate program on rapid prototyping of solid polymer electrolyte rechargeable ambient temperature batteries to provide power for a wide range of manportable military electronic equipment, in addition to laptop computers, cellular phones, and other portable electronics.
- (U) Vapor Phase Processing (\$12.3M): Develop low-cost processing of diamond films and photovoltaics for electronic applications.
 - (U) Complete sensor and control system development for chemical vapor deposition reactor technologies; implement second-generation control systems on direct current (DC) arc reactor systems; increase diamond manufacturing throughput with increased deposition rate, area and yield.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602712E

PE Title: Materials and Electronics Technology

Project Number: MPT-01

Date: September 1993

Budget Activity: 1. Technology Base

- (U) Demonstrate feasibility for low-cost, high-rate, high materials utilization efficiency manufacturing of copper-indium-diselenide multilayer photovoltaics using cylindrical magnetron sputtering.
- (U) FY 1995 Planned Program:
 - (U) Biotechnology (\$1.9M): Complete program and transition to Military Medicine/Trauma Care Technology Program.
 - (U) Demonstrate biosensor device gain by modulation of intrinsic cellular amplification system (second messenger system) and complete cell-based biosensor.
 - (U) High Temperature Structural Materials (\$24.9M): Develop affordable composites using intelligent processing of materials concepts.
 - (U) Demonstrate on-line sensing of critical product and process variables and multivariable feedback control of the rapid densification manufacturing process for carbon-carbon composites.
 - (U) Demonstrate economic polymer composite manufacturing using advanced fiber placement techniques.
 - (U) Develop advanced electron beam curing process suitable for on-line production of polymer matrix composites.
 - (U) Scale up manufacturing capabilities to produce fiber reinforced titanium matrix composite hollow fan blades for jet engines.
 - (U) Demonstrate quality and cost benefits resulting from the application of intelligent processing of materials to the manufacture of silicon carbide monofilament fibers.
 - (U) Demonstrate the reduced mean time between failure (MTBF) associated with the upgrade of glass optical domes to spinel optical domes used in the Angle Rate Bombing Set (ARBS) of the AV-8B Harrier aircraft.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602712E

PE Title: Materials and Electronics Technology

Project Number: MPT-01

Budget Activity: 1. Technology Base

Date: September 1993

- (U) Material and Device Manufacturing (\$31.0M): Extend program to address hard and soft tooling, laser cutting and manufacturing capabilities for multi-chip modules.
 - (U) Develop prototype design for adaptively-controlled machine tools.
 - (U) Develop control scheme to correct machine errors.
 - (U) Demonstrate aberration corrections in fiber optics at 1 kilowatt average power for continuous wave (CW) lasers to enhance cutting accuracy.
 - (U) Develop and apply sensor technologies for on-line process control for the large-format and roll-to-roll unit manufacturing tools identified for development of multi-chip modules.
 - (U) Demonstrate performance of large format unique materials in the manufacture of multichip modules.
- (U) Advanced Materials and Processing (\$24.8M): Continue processing developments for affordable materials.
 - (U) Improve defect density in semiconducting silicon carbide boules to optimize electrical properties and increase yield.
 - (U) Model, simulate and characterize optical interconnects, and crystal growth of new laser and non-linear optical materials.
 - (U) Demonstrate smart materials manufacturability.
 - (U) Develop theoretical and computational methods to predict structural and electro-optic properties for semiconductor overlayers.
- (U) Vapor Phase Processing (\$16.5M): Expand program to include plasma processing.
 - (U) Initiate effort to develop reliable plasma database for computer-aided design of advanced plasma reactors.
 - (U) Initiate effort to develop modeling and simulation tools for surface process, plasma generation and transport, and plasma-surface interactions.
 - (U) Demonstrate cost-effective, intelligent manufacturing of multilayered micro-composite structures; demonstrate high-yield, high throughput manufacturing of multilayer photovoltaics.
 - (U) Finalize optimal diamond manufacturing technologies. Develop military customer applications for thermal management diamond substrates.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602712E Project Number: MPT-01 Date: September 1993
PE Title: Materials and Electronics Budget Activity: 1. Technology Base

Technology

- (U) Environmental Sciences (\$11.0M): Eliminate DoD toxic waste using supercritical water oxidation (SCWO). Reduce toxic waste production as by-products of DoD-related manufacturing processes ("green" manufacturing).
 - (U) Exploit supercritical water oxidation (SCWO) technology and initiate construction of transportable SCWO system capable of processing 1000 gallons per day.
 - (U) Develop alternative manufacturing processes for minimization/elimination of toxic wastes.
- (U) **FY 1996 Planned Program:**
- (U) High Temperature Structural Materials (\$12.2M): Complete demonstrations of affordable composite manufacturing and ceramic insertion.
 - (U) Demonstrate cost-effective manufacturing of carbon-carbor composite materials in the pilot-line production facility with on-line sensing and feedback process control.
 - (U) Establish pilot line for polymer composite production and demonstrate the affordability payoffs.
 - (U) Demonstrate the reduced life cycle costs and operational reliability of ceramic matrix composite flaps and seals on the F110 engine compared to current metallic bill of materials.
 - (U) Material and Device Manufacturing (\$38.3M): Optimize fabrication process, enhance research on intelligent process controls for structures and multi-chip modules.
 - (U) Produce and test adaptively controlled machine tool.
 - (U) Demonstrate prototype robotics system with fiber optic delivery of laser energy at 3-to-5 kilowatt.
 - (U) Demonstrate precision cutting, drilling, and joining of metal matrix composites and high strength metal alloys.
 - (U) Demonstrate large-format and roll-to-roll manufacturing processes incorporating cost-effective materials, on-line sensing, predictive models and multivariable process control for multi-chip modules.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602712E

PE Title: Materials and Electronics
Technology

Project Number: MPT-01

Budget Activity: 1. Technology Base

Date: September 1993

- (U) Advanced Materials and Processing (\$25.9M): Continue processing development for affordable materials, devices and structures.
 - (U) Demonstrate smart material structural control in two vibration suppression and control applications.
 - (U) Demonstrate smart material structural control in one large-scale shape control application.
 - (U) Develop high temperature contacts and improved characteristics for semiconducting silicon carbide electronic devices.
 - (U) Extend modeling of electronic structure via quantum molecular modeling of molecule-surface interactions.
- (U) Vapor Phase Processing (\$17.6M): Productize components and perfect reactors.
 - (U) Demonstrate cost-effective system applications for multilayered micro-composite structures and the jet vapor deposition process.
 - (U) Demonstrate full process intelligent manufacturing of multilayer photovoltaic systems.
 - (U) Design and construct first generation of advanced plasma etching reactor by incorporating the validated plasma database and simulation models.
 - (U) Complete new instrumentation for real-time; in-situ monitoring for control and analysis of plasma process expert systems.
- (U) Environmental Science (\$15.0M): Expand "green" manufacturing and scale up supercritical water oxidation (SCWO) equipment.
 - (U) Demonstrate reduced toxic waste in manufacturing of organic composites, lead-free solders, and electronic materials.
 - (U) Construct SCWO pilot plant and demonstrate utility on aircraft carrier.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602712E

Date: September 1993

Project Number: MPT-01

PE Title: Materials and Electronics Technology

Budget Activity: 1. Technology Base

D. (U) WORK PERFORMED BY: Major performers are: United Technologies Research Center, East Hartford, CT; General Electric Corporation, Schenectady, NY; Sandia Laboratories, Livermore, CA; Norton Company, Northboro, MA; 3M Corporation, St. Paul, MN; Allied Signal Aerospace Company, Phoenix, AZ; Pratt & Whitney, West Palm Beach, FL; Lanxide Corporation, Newark, DE; General Dynamics, Groton, CT; Raytheon Corporation, Tewksbury, MA; Textron Special Materials, Lowell, MA; and University of Texas, Austin, TX.

E. (U) RELATED ACTIVITIES: ARPA's research on Materials Processing is coordinated within DoD and with other federal agencies via the Office of Science and Technology Policy Committee on Material (COMAT) and various DoD and other topical workshops on materials and materials processing.

F. (U) OTHER APPROPRIATION FUNDS: None.

G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602712E
PE Title: Material and Electronics
Technology

Project Number: MPT-02 Date: _____
Budget Activity: 1. Technology Base

Date: September 1993

Project

[illegible]

B. (U) BRIEF DESCRIPTION OF PROJECT: This project develops advanced electronic and optoelectronic devices, semiconductor process tools and methodologies, and materials for infrared devices. Areas of emphasis include high-performance analog-to-digital converters (ADCs), military optical processors, novel optoelectronic devices and modules, artificial neural network technology, low power electronics and semiconductor process design and synthesis. Beginning in FY 1994, efforts previously included in MPT-03 are consolidated within this project. Also, efforts in ADCs and optoelectronics previously funded under Program Element 0601101E, Defense Research Sciences, have transitioned to this project starting in FY 1994. This microelectronics development project creates the technology base for advanced electronic and optoelectronic components to meet DoD needs in all DDR&E thrust areas.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602712E Project Number: MPT-02 Date: September 1993
PE Title: Material and Electronics Budget Activity: 1. Technology Base

Technology

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program:

- (U) Demonstrated Microelectronics Manufacturing Science and Technology (MMST) fabrication cycle time and yield improvements on a 1000-wafer fabrication run.
- (U) Demonstrated MMST fabrication flexibility by processing two distinct process flows.
- (U) Demonstrated MMST capability to fabricate an externally designed circuit.
- (U) Completed design of Gallium Arsenide (GaAs) heterojunction bi-polar transistor (HBT) analog-to-digital converters (ADCs) for ultra-high-speed conversion of microwave signals to digital form for advanced signal processing.
- (U) Completed fabrication line assembly for HBTs.
- (U) Initiated effort to develop models applicable to 100 gigahertz (GHz) HBTs.
- (U) Developed neural network techniques for automatic target recognition.
- (U) Demonstrated compact neural network sensing, tracking, and recognition system.
- (U) Completed development of acoustic charged transport (ACT) chip manufacturing capability.
- (U) Scaled infrared substrate growth process to produce wafers with twice the single-crystal area.
- (U) Developed process for low-cost ferroelectric non-volatile memory. (MPT-03)
- (U) Demonstrated real-time, compact synthetic aperture radar (SAR) with spotlight mode. (MPT-03)
- (U) Demonstrated steering of wide-band radar beam with optical control module. (MPT-03)
- (U) Initiated university-industry optoelectronics centers. (MPT-03)

(U) FY 1994 Planned Program:

- (U) Test first iteration GaAs HBT-based ADCs for sampling speed and dynamic range. (\$7.0M)

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602712E

Project Number: MPT-02 Date: September 1993

PE Title: Material and Electronics Technology

Budget Activity: 1. Technology Base

- (U) Complete design and demonstration of GaAs HBT-based ADC support components, such as multiplexers and demultiplexers. (\$4.0M)
- (U) Initiate effort to develop a design system for circuits operating above 10 GHz. (\$2.7M)
- (U) Develop neural network nonlinear adaptive filters for signal processing applications. (\$0.6M)
- (U) Develop neural network automatic target recognition systems for future insertion into specific military platforms, including the Comanche helicopter. (\$1.7M)
- (U) Initiate development of neural network speech recognition systems and multi-modal (speech, lip-reading, gestures, eye-tracking) command systems for computer interfaces. (\$1.5M)
- (U) Develop first-generation neural network board-level electronic hardware capable of up to 10 billion connections per second. (\$2.0M)
- (U) Develop component technologies for optoelectronic neural network hardware capable of up to 100 trillion connections per second. (\$1.5M)
- (U) Demonstrate a prototype neural network-based process control system. (\$0.6M)
- (U) Complete design study for implementing an Advanced Vision System (AVIS) that utilizes neural networks and other advanced algorithms. (\$2.0M)
- (U) Demonstrate optically controlled phased arrays and fiber-optic-based bistatic radar. (\$3.7M)
- (U) Demonstration of optical pattern recognition modules. (\$2.2M)
- (U) Demonstrate acousto-optic pulse compression signal processor and jammer nulling processor. (\$2.4M)
- (U) Demonstrate optical electronic warfare channelizer and precision direction finder. (\$1.7M)
- (U) Develop integrated monolithic tunable laser arrays. (\$3.2M)
- (U) Develop packaged optoelectronic-microwave modules for microwave transmission. (\$3.5M)
- (U) Initiate efforts to develop low-cost optoelectronic module manufacturing technologies. (\$16.5M)

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602712E Project Number: MPT-02 Date: September 1993
PE Title: Material and Electronics Budget Activity: 1. Technology Base

Technology

- (U) Develop optoelectronic packages that incorporate passive alignment techniques between fibers and component input/output (I/O). (\$3.4M)
- (U) Establish consortia for rapid automated optical alignment packaging and for accelerate development of blue lasers for insertion into laser memory disk systems. (\$8.0M)
- (U) Improve ferroelectric memory cell performance, especially imprint characteristics. (\$1.4M)
- (U) First pass design of process synthesis framework architecture. (\$5.6M)
- (U) Development of the process synthesis architecture data base methodology. (\$5.3M)

(U) FY 1995 Planned Program:

- (U) Demonstrate the high-speed heterojunction bi-polar transistor (HBT) process via components in a system application. (\$2.5M)
- (U) Develop and demonstrate high-speed HBT technology on pilot lines. (\$15.8M)
- (U) Apply neural network nonlinear adaptive filters to specific communication demodulation, direction-finding, and other signal processing applications. (\$1.5M)
- (U) Begin insertion of neural network automatic target recognition systems into specific military platforms, including the Comanche helicopter. (\$2.8M)
- (U) Develop prototype large-vocabulary speech recognition systems and develop data fusion techniques for exploiting multiple modes of communication. (\$3.0M)
- (U) Demonstrate electronic neural network board-level systems on specific signal processing applications. (\$2.0M)
- (U) Demonstrate speeds of 1 trillion connections per second in first generation optoelectronic neural network hardware systems. (\$2.0M)
- (U) Demonstrate initial concepts of affordable optoelectronic modules. (\$12.0M)
- (U) Field demonstration of optical pattern recognition modules and optical real-time synthetic aperture radar processor. (\$1.0M)
- (U) Demonstrate advanced serial and parallel optoelectronic busses. (\$6.0M)

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602712E Project Number: MPT-02 Date: September 1993
PE Title: Material and Electronics Budget Activity: 1. Technology Base

Technology

- (U) Initiate insertion of prototype optoelectronic modules into system applications. (5.0M)
- (U) Establish manufacturing infrastructure for optoelectronic modules. (4.3M)
- (U) Develop processing protocols for reliable, high yield, dense (256 Kilobit) ferroelectric non-volatile memory. (\$2.3M)
- (U) Final design of the process synthesis framework architecture. (\$1.0M)
- (U) Definition of the process description language and parameters. (\$2.9M)
- (U) Design and documentation of the procedure for translating process specifications to tool control recipes. (\$1.0M)
- (U) Development of product description analysis tools. (\$2.0M)
- (U) Development of process synthesis interface tools. (\$2.0M)
- (U) Development of a complete product simulator. (\$2.0M)
- (U) Demonstration of the process synthesis framework functionality. (\$2.0M)
- (U) Develop physics and chemistry based process and equipment models for process tool control. (\$1.1M)
- (U) Enhance work on measurements of process equipment-state and state-recovery methods. (1.0M)
- (U) Model and simulate real-time control methodologies developed in FY94 and demonstrate implementation in one manufacturing tool. (\$0.6M)
- (U) Development of reliability prediction simulation. (\$0.6M)
- (U) Establish Advanced Vision System (AVIS) architecture framework and initiate embedded hardware development. (\$8.0M)
- (U) Validate high-speed heterojunction bi-polar transistor (HBT) technology by manufacturing components on one pilot production line. (\$2.0M)
- (U) Initiate development of device, architecture and power management technology to lower power consumption of semiconductor electronics by 100 times. (\$17.5M)
- (U) Development of manufacturing rule checker. (\$2.0M)

(U) FY 1996 Planned Program:

- (U) Validate high-speed heterojunction bi-polar transistor (HBT) technology by

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602712E
 PE Title: Material and Electronics Technology
 Project Number: MPT-02 Date: September 1993
 Budget Activity: 1. Technology Base

- (U) manufacturing components on remaining pilot production lines. (\$8.0M)
- (U) Document HBT production process. (\$0.6M)
- (U) Insert neural network nonlinear adaptive filters into the DSCS III modem and specific intelligence platforms. (\$3.0M)
- (U) Insert neural network automatic target recognition systems into specific missile seeker platforms. (\$2.3M)
- (U) Incorporate research on dynamic neural networks and demonstrate high-performance neural network speech recognition systems and multi-modal commands for computer interfaces. (\$3.0M)
- (U) Demonstrate compact optoelectronic neural networks operating at 100 trillion connections per second on a high-resolution image recognition application. (\$3.7M)
- (U) Insertion of affordable optoelectronic modules into computer systems. (\$13.7M)
- (U) Demonstrate optical interconnect for multichip modules. (\$4.0M)
- (U) Demonstrate smart pixel-based optical interconnect with built-in logic. (\$7.0M)
- (U) Initiate optoelectronic sensors for remote sensing applications including hazardous environments (\$5.0M)
- (U) Develop components at visible wavelengths for low cost interconnects. (\$5.0M)
- (U) Development of a complete product simulator. (\$6.0M)
- (U) Demonstration of a manufacturing rule checker. (\$3.0M)
- (U) Demonstration of a process sequence optimizer. (\$1.0M)
- (U) Development of product description analysis tools. (\$2.8M)
- (U) Demonstration of full-up process synthesis framework. (\$2.8M)
- (U) Continue demonstration of real-time control methods. (\$1.5M)
- (U) Continue reliability prediction simulation methods. (\$1.0M)
- (U) Initiate investigation of fuzzy logic methods for real-time process control in a multivariable environment. (\$0.5M)
- (U) Initiate investigation of on-wafer sensing for process control. (\$0.4M)
- (U) Demonstrate capability for producing VLSI circuits, power converters and circuit architectures that operate at less than 1.5 volts and have reduced parasitic

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602712E Project Number: MPT-02 Date: September 1993
PE Title: Material and Electronics Budget Activity: 1. Technology Base

Technology

- capacitances by a factor of 10. (\$17.5M)
- (U) Complete automatic target recognition (ATR) sensitivity studies and downselect algorithmic approach for hardware implementation. (\$10.0M)

D. (U) WORK PERFORMED BY: TRW, Los Angeles CA; Rockwell, Anaheim, CA; Hughes Research Laboratory, Malibu, CA; Harris, Melbourne, FL; Texas Instruments, Dallas, TX; Lincoln Lab, Lexington, MA; Hughes Aircraft Company, Malibu, CA; Honeywell, Minneapolis, MN; Worcester Polytechnic Institute, Worcester, MA; University of Southern California, Los Angeles, CA; Erim, Ann Arbor, MI; and Arizona State University, Tempe, AZ.

E. (U) RELATED ACTIVITIES: The work is coordinated with Service research efforts through the Advisory Group on Electron Devices and via annual government-wide program reviews. These activities assure that no duplication of effort occurs.

F. (U) OTHER APPROPRIATION FUNDS: None.

G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #06027112E Project Number: MPT-06 Date: September 1993
 PE Title: Materials and Electronics Budget Activity: L. Technology Base Technology

A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1993 Actual	FY 1994 Estimate	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	To Complete	Total Program
MPT-06 High Temperature Superconductivity (HTSC)	35,461	37,788	14,238	10,000	0	0	0	0	*220,093

* Total Program reflects both MPT-06 (97,687) and PE 0602301E, project ST-16 (122,406) where program was previously funded.

B. (U) BRIEF DESCRIPTION OF PROJECT: High temperature superconducting (HTS) materials have reached a stage of development when specific applications can be identified in thin-film electronic devices and circuitry for military avionics, with concomitant benefit to commercial electronics. The ARPA program is building specific insertions for radar and electronic detection systems with extremely wide bandwidth and dynamic range, general avionics, and airframe guidance subsystems, while continuing with the development of the underlying fabrication technology for thin films, bulk wire and other forms. Particular demonstrations include a switched filterbank for the B-1B radar warning receiver, superconducting electronic packages for electronic intelligence (ELINT) and electronic warfare suites in reconnaissance aircraft, and safe and economical devices for riveting and clamping sheet metal sections for aircraft manufacturing.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

- (U) FY 1993 Program:
- (U) Demonstrated operation of multichip modules which employ HTS interconnects in digital receiver circuits.
 - (U) Demonstrated integrated HTS radio frequency (RF) components in electronic warfare and communications systems.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602712E

PE Title: Materials and Electronics Technology

Project Number: MPT-06

Date: September 1993

Budget Activity: 1. Technology Base

- (U) Initiated active, digital, cryoelectronics development based on flux-trapped quantum logic, applied to high resolution analog/digital (A/D) converter or digital radio frequency memory.

- (U) FY 1994 Planned Program:
 - (U) High Temperature Superconductors/Analog and Digital Applications (\$23.5M): Address insertions for high temperature superconducting (HTS) materials in thin-film analog and digital electronic devices and circuitry. Transition the technology to applications such as computer-aided engineering (CAE) software tools for HTS circuit characterization and optimization, and integration of available cryogenic refrigerators with HTS devices.
 - (U) Continue development of optically-switched 30 element HTS filterbank to enable signal discrimination in radar warning receivers (RWR) in a dense countermeasures environment.
 - (U) Improve acoustical damping of stabilized oscillator (STALO) based upon high-Q HTS/sapphire resonant cavity, to achieve factor of 100 improvement over current radars.
 - (U) Characterize performance criteria for radar receiver to detect sea-skimming missiles at adequate ranges in sea clutter, based upon HTS reference source and preselective filterbank integrated with low-noise antenna driver and appropriate closed-cycle cryogenic cooling system.
 - (U) Undertake development of an HTS crossbar switch to provide very high connectivity and performance enhancement (X5) over current capability, for application to mainframe computers and telecommunications.
 - (U) Fabricate digital circuits such as an asynchronous transfer mode (ATM) switch for the DoD global grid network and/or the commercial information infrastructure.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602712E

PE Title: Materials and Electronics Technology

Project Number: MPT-06

Date: September 1993

Budget Activity: 1. Technology Base

- (U) Incorporate HTS analog components in cellular telephone and personal communications networks, utilizing the high-power handling and discrimination capability of thin-film HTS tuned filterbanks, delay lines and other components to provide enhanced coverage with better unit isolation.
- (U) Develop wide-bandwidth high temperature superconducting (HTS) antennas and high-efficiency HTS coupling networks for application as miniaturized radio frequency (RF) sensors and transmitters in electronic warfare scenarios.
- (U) High Temperature Superconductors/Multi-Chip Modules (MCM) (\$14.3M): Demonstrate a fully functional module utilizing approximately 50 complementary metal oxide semiconductor (CMOS) chips which will operate with 2X greater speed in a more compact form.
 - (U) Extend materials processing capabilities to develop ion etching as a planarization technique for insulating dielectric layers and develop photoresist and etching procedures to attain fully reproducible 2 micron interconnect linewidth.
 - (U) Develop technology infrastructure by extending commercial computer-aided engineering (CAE) tools for normal metal interconnects to accommodate HTS interconnects, transitioning such capability to HTS vendors and MCM manufacturers.
 - (U) Develop alternate HTS MCM architectures such as the dual-offset mesh plane process.
 - (U) Integrate closed-cycle cryofrigerator with MCM module for a complete push-button system.

(U) FY 1995 Planned Program:

- (U) High Temperature Superconductors/Analog and Digital Applications (\$14.2M): Select the most promising HTS applications to achieve the planned ramping down of the program. (1) filterbank for suppressing radio warning receivers (RWR) saturation,

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602712E

PE Title: Materials and Electronics
Technology

Project Number: MPT-06

Date: September 1993

Budget Activity: 1. Technology Base

- (2) high resolution radar receiver development, (3) crossbar switch as a component in computers, and (4) analog components applied to communication networks.
- (U) Extend the switched high temperature superconducting (HTS) filterbank to be fully compatible with the radar warning receivers (RWR) requirements of several aircraft E-W suites.
- (U) Integrate the stabilized oscillator (STALO) with the low-noise antenna driver and preselective filterbank to determine if the noise floor meets performance requirements to detect sea-skimmers.
- (U) Undertake complementary metal oxide semiconductor (CMOS) optimization according to the design proven with gallium arsenide (GaAs) components in room-temperature crossbar switch and characterize performance at low temperature with HTS interconnects.
- (U) Demonstrate function of filter networks, delay lines and other components according to specifications in subscale versions of communication networks.

(U) FY 1996 Planned Program:

- (U) High Temperature Superconductors/Analog and Digital Applications (\$10.0M): The HTS program will terminate with further selections made among the most promising candidates. Likely selections are: (1) demonstration of a high resolution radar receiver, (2) development of a crossbar switch as a component in computers, and (3) analog components applied to communication networks.
- (U) Insert HTS components within an operational radar set and demonstrate the improved dynamic range and the ability to discriminate very small objects in the presence of clutter.
- (U) Demonstrate cryogenic operation of a crossbar with HTS interconnects with improved speed and networking capability.
- (U) Transition development of filterbanks and other analog components to commercial usage in communications.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602712E Project Number: MPT-06 Date: September 1993
PE Title: Materials and Electronics Budget Activity: 1. Technology Base Technology

D. (U) WORK PERFORMED BY: Major performers include: Superconductor Technologies, Inc., Goeleta, CA; Conductus, Inc., Sunnyvale, CA; Massachusetts Institute of Technology, Cambridge, MA; N-Chip, San Jose, CA; E-Systems, Falls Church, VA; Honeywell Corporation, Minneapolis, MN; Boeing Corp., Seattle, WA; Westinghouse Corporation, Baltimore, MD; and DuPont Corporation, Wilmington, DE.

E. (U) RELATED ACTIVITIES: Research is coordinated within DoD and with other federal agencies via the Office of Science and Technology Policy (OSTP) Committee on Materials (COMAT), HTS Coordinating Committee, and numerous workshops involving industry, universities and government laboratories.

F. (U) OTHER APPROPRIATION FUNDS: None.

G. (U) INTERNATIONAL COOPERATION AGREEMENTS: Not applicable.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602712E
 PE Title: Materials & Electronics Technology
 Project Number: MPT-07 Date: September 1993
 Budget Activity: 1. Technology Base

A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1993 Actual	FY 1994 Estimate	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	To Complete	Total Program
MPT-07	0	0	26,016	30,000	28,002	20,998	0	0	105,016

B. (U) BRIEF DESCRIPTION OF PROJECT: This project is a continuation and coordination of work previously cited under program element 0601101E (MS-01, ES-01, CCS-02), 0602301E (ST-11), and 0602712E (MPT-01). The objective is to revolutionize far-forward battlefield trauma care. The project recognizes that planned downsizing of U.S. forces creates concomitant pressure to ensure force readiness, skill mix, and effective joint doctrine at a time when battlefield casualties carry both strategic importance and tactical relevance. A review of combat casualty care has shown: (1) that 90% of combat deaths occur in the zone of close combat prior to medical or surgical intervention; (2) that fratricide continues at casualty rates as high as 20%-30%; (3) that casualty location is a continuing battlefield problem; (4) that less than 5% of U.S. Army active-duty physicians have treated combat casualties; (5) that realistic peacetime combat medical/surgical training is minimal; (6) that combat medic training is limited, and constrained by the use of live animal experimentation; and (7) that medical theater-of-war communications are archaic and non-functional.

(U) This project exploits ARPA's unique leadership role in the electronics and information sciences to project advanced medical and surgical care into the far-forward battlefield area to effect early, successful, clinical intervention. Work will develop light-weight personnel status monitors (PSMs) permitting remote non-invasive clinical diagnosis, casualty localization, and friend-foe identification. The PSM, which would be worn by all soldiers as part of their combat uniforms, is further augmented with low power, secure, wireless communications. The PSM would monitor the soldiers' clinical vital signs continuously, but would remain otherwise passive

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602712E

PE Title: Materials & Electronics
Technology

Project Number: MPT-07

Date: September 1993

Budget Activity: 1. Technology Base

unless either queried by an operational commander or the soldiers' vital signs departed from established clinical norms. Use of the personnel status monitor (PSM) should reduce mortality in three ways: (1) it will prevent or reduce casualties from friendly fire by increasing command awareness of precisely where soldiers are located on the battlefield; (2) it will enable combat medics to initiate triage within moments of a soldier's wounding and, because the precise location of the wounded soldier and the critical level of injury or shock is known, will allow medics and surgeons to optimize available treatment and evacuation; and (3) it will identify dead soldiers and thus obviate the need to send evacuation teams into hostile environments.

(U) The program will develop the technology base for (early) far-forward medical/surgical intervention. The goal is to preserve critical organ system function, prevent exsanguination, reverse systemic shock, and prevent hypoxia by use of automatically controlled devices to provide immediate mechanical or pharmacologic therapy. Once pharmacologic or early surgical stabilization has been achieved, the patient will be evacuated in a critical care pod (CCP). The CCP will allow long-range evacuation under controlled physiologic and closed cycle environmental conditions, and will function like a hospital intensive care unit. The CCP will have the capacity for intrasit monitoring of vital signs, will preserve stability by administering fluids, drugs, or summoning human intervention, will mechanically support vital functions, and will provide protection from natural or militarily hostile environments. It will develop enhanced, field portable, digital imaging capabilities for critical examination of wounded combatants, and facilitate real-time transmission of high resolution clinical imagery for analysis by specialists located outside the far-forward combat zone. Initial efforts will focus on the realization of field-portable battlefield digital X-ray imaging systems. This project further develops and exploits capabilities in telemedicine.

(U) This program will develop and exploit advanced simulation technology to improve the training of battlefield health care providers and to insure skill currency. The objectives of this effort are to provide for the virtual representation of human structure and function; insure near-seamless transition from training to clinical practice; and to permit simulation of combat-casualty medical care within the framework of operational battlefield requirements. In a

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602712E

PE Title: Materials & Electronics
Technology

Project Number: MPT-07

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Budget Activity: 1. Technology Base

setting that forgives mistakes, residents and surgeons can practice surgical approaches or plan the strategy for the next day's surgery while the simulator illustrates the consequences of their surgical judgments. The broad sweep of physical examination, clinical diagnosis, and the pharmacologic consequences of intervention can be made part of a seamless human learning experience that permits the physician to go from a "review" on the simulator to direct interaction with the patient. The broader impact of whole-body virtual simulation on undergraduate and continuing medical education programs will allow medical students to integrate traditionally separate academic disciplines and dramatically reduce the need for human cadavers and live-animal experimentation.

(U) The development of an advanced healthcare information infrastructure supports the entire trauma care technology base. Medical information must flow seamlessly and transparently on all levels of patient care. For this to occur, a platform-independent medical record system, such as the battlefield electronic patient record (BEPR), will insure immediate continuity, distribution, and accessibility of medical information from the forward battlefield to the rear echelon support in U.S. based medical centers. This information will be archived in multimedia heterogeneous databases of laboratory studies, radiologic and pathologic images, inpatient medical records, and be available over a world wide telecommunication system for real-time interactive collaboration among physicians. In addition, the infrastructure will provide a clinical associate system which is an intelligent system that assists physicians, nurses, corpsmen and paramedics in assessing and treating patients.

(U) All elements of this project have application to the civilian health care system with the promise of improving physical accessibility to care, improving quality of care, insuring continuity of care, and reducing health care costs.

(U) This work does not duplicate any efforts of the military services or the National Institutes of Health. For a discussion of planning and coordination see section E, "Related Activities."

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602712E Project Number: MPT-07 Date: September 1993
PE Title: Materials & Electronics Budget Activity: 1. Technology Base
Technology

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program: Not applicable.

(U) FY 1994 Planned Program: Not applicable.

(U) FY 1995 Planned Program:

- (U) Advanced Biomedical Technology. (\$16.0M)
 - (U) Develop personnel status monitor (PSM) primary sensors; executive (controller) breadboard; PSM sensor algorithm, code and system integration; medic/command data management and decision support; miniaturized personal communications for GPS module; interface and integrate communications to controller subsystem; in-house and field testing.
 - (U) Develop battlefield surgical simulation for lower extremities with emphasis on kinematic realism, soft tissue deformation, muscle contractility and simple bleeding (virtual environment).
 - (U) Prototype miniature x-ray source and direct digitizing detector array.
 - (U) Initiate exploratory studies of telepresence surgery (on experimental model) by wireless link between contingency field hospital and remote field operating room; critical care pod with integrated vital signs monitoring and closed cycle environmental control.
- (U) Health Care Information Infrastructure. (\$10.0M)
 - (U) Develop software architecture for a user-oriented associate system that captures ambulatory care data directly from physicians during patient visits.
 - (U) Develop associate system that provides trauma guidelines directly to medics during emergencies and combat care scenarios.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602712E

PE Title: Materials & Electronics
Technology

Project Number: MPT-07

Date: September 1993

Budget Activity: 1. Technology Base

- (U) Demonstrate shared electronic, graphic based planning and collaboration tools for multiple users in a distributed health and human services associate system.
- (U) FY 1996 Planned Program:
 - (U) Advanced Biomedical Technology. (\$18.0M)
 - (U) Develop personnel status monitor (PSM) with multiple lead electrocardiogram (ECG) and advanced diagnostic algorithms, thoracic impedance with algorithms for determination of cardiac output and alveolar ventilation rate, galvanic skin response; secondary sensor parameter protocol development, command unit optimization and display/decision support. Initiate enhanced communications (including video); differential geo-positioning system (GPS) and vectoring.
 - (U) Surgical simulation capability puts emphasis on increased physiological mimicry; introduce semi-autonomous forces into virtual battlefield for medical force planning and training.
 - (U) Digital imagery efforts put focus on improved resolution of digital x-ray imagery; x-ray source reduction; miniaturized computerized axial tomography/magnetic resonance imagery (CT/MRI) for extremity analysis and contingency hospital use; image compression for transmission/storage.
 - (U) Initiate exploratory studies of critical care pod efforts extended to integration of miniaturized ventilator, introduction of closed-loop therapeutics with expert systems, environmental temperature control and adaptation to mobile evacuation platforms; telepresence surgery expands surgical capabilities and explores adaptation into mobile platforms.
 - (U) Health Care Information Infrastructure. (\$12.0M)
 - (U) Integrate user-task models and knowledge-based decision support tools that provide patient-specific clinical practice guidelines to the physician during data entry.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0602712E

Date: September 1993

Project Number: MPT-07

PE Title: Materials & Electronics

Budget Activity: 1. Technology Base

Technology

- (U) Demonstrate hands-free capture of patient data during emergencies and combat casualty scenarios that is directed from trauma guidelines using mixed model human computer interaction techniques.
- (U) Integrate user-defined service and telecommunications protocols that permit one-stop shopping for geographically dispersed clients.

D. (U) WORK PERFORMED BY: To be determined. Broad Area Announcement (BAA) is expected to be published during the first quarter of FY 1994.

E. (U) RELATED ACTIVITIES: Work coordinated with the U.S. Army (Medical) Advanced Technology Process Action Team, tri-service Medical R/D components, tri-service Medical R/D Command Council, the Surgeons General of the tri-services, the National Library of Medicine, the National Institutes of Health, the National Science Foundation, the Uniformed Services University of the Health Sciences, the Joint Special Operations Command School of Medicine, and the U.S. Army Warfighting Simulation Center Dismounted Landwarrior (TRADOC) Testbed.

F. (U) OTHER APPROPRIATION FUNDS: None.

G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FY 1995-1996 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603226E Date: September 1993
 PE Title: Experimental Evaluation of Budget Activity: 2. Advanced Technology Development
 Major Innovative Technologies

A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1993 Actual	FY 1994 Estimate	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	To Complete	Total Program
EE-21 Close Combat 1(8,993) 2(4,523)			27,750	33,750	44,060	53,960	48,282	Continuing	Continuing
EE-23 Enhanced Fighter Maneuverability 8,758 0			0	0	0	0	0	0	103,194
EE-24 ASTOVL 4,770		19,712	19,039	1,954	0	0	0	Continuing	Continuing
EE-27 Advanced Space Technology Program 14,711 30,213		11,435	11,944	12,014	4,031	7,745	Continuing	Continuing	Continuing
EE-30 Smart Weapons Application Program 7,203 0		0	0	0	0	0	0	0	50,131
EE-34 Guidance Technology 13,260 6,329		10,907	18,937	16,000	15,000	0	Continuing	Continuing	Continuing
EE-36 Advanced ASW Technology 10,721 13,680		18,385	18,692	18,496	22,614	23,550	Continuing	Continuing	Continuing

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FY 1995-1996 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603226E Date: September 1993
 PE Title: Experimental Evaluation of Budget Activity: 2. Advanced Technology--
 Major Innovative Technologies Development

EE-37	Advanced Simulation	43,443	55,993	80,368	76,897	40,675	65,003	54,978	Continuing	Continuing
EE-39	Unmanned Undersea Vehicle Systems	15,880	17,952	17,839	17,900	17,571	17,395	18,115	Continuing	Continuing
EE-40	Critical Mobile Targets	34,724	104,553	124,654	117,537	114,303	113,162	115,795	Continuing	Continuing
EE-41	Air Defense Initiative	3(32,018)	27,717	40,600	31,600	32,000	41,000	41,000	Continuing	Continuing
EE-43	Alternative Power Sources	54,539	0	10,000	14,488	24,514	30,000	30,000	Continuing	Continuing
EE-44	Wingship	5,000	0	0	0	0	0	0	0	5,000
EE-45	Global Grid Communications	0	20,881	42,843	45,926	39,842	32,592	5,435	Continuing	Continuing
EE-CLS/ADI		73,960	215,168	207,939	208,378	240,746	277,591	290,412	Continuing	Continuing
		286,969	512,198	611,759	598,003	600,221	672,348	635,312		

1 previously funded in OSD PE 0603737D

2 previously funded in PE 0602702E

3 previously funded in OSD PE 0603741D

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FY 1995-1996 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603226E

PE Title: Experimental Evaluation of
Major Innovative Technologies

Date: September 1993

Budget Activity: 2. Advanced Technology
Development

B. (U) BRIEF DESCRIPTION OF ELEMENT: The purpose of this program is to demonstrate and evaluate advanced research and development concepts. Twelve projects are funded within this program element such as the Air Defense Initiative, the Critical Mobile Targets, Advanced Simulation, Advanced Space Technology, and Global Grid Communications projects. A number of advanced technology demonstrations are funded within these twelve activities and several projects have dual-use applications. A discussion of the most significant projects follows.

(U) The Air Defense Initiative (ADI) is examining innovative technologies to counter the airborne threat posed by cruise missiles and manned aircraft. Technologies under evaluation include sensor upgrades, data integration and identification improvements, and radar-absorbent materials research. Advanced infrared measurement and high resolution digital imagery systems are also under development, and a simulation and modelling effort is included to test and demonstrate ADI concepts.

(U) Advanced Simulation efforts will provide a distributed, scalable seamless warfighting environment at the weapon level of detail that will ultimately provide a massive synthetic theater of war capable of supporting such requirements as readiness training, doctrine refinement, requirements analysis, battle management simulation, and contingency planning. Communications and data infrastructures, range instrumentation and computer image generation are just a few of the developmental activities funded in the Advanced Simulation program.

(U) The Critical Mobile Targets (WAR BREAKER) project is developing a comprehensive system of sensors, communication suites, and information processing systems to detect, identify, and prosecute high value, time-critical fixed and mobile targets such as theater ballistic missiles, tanks, and artillery.

(U) Building on prior success in small satellite and launch vehicle programs, the Advanced Space Technology program will continue to develop technological improvements to improve the

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FY 1995-1996 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603226E

Date: September 1993

PE Title: Experimental Evaluation of
Major Innovative Technologies

Budget Activity: 2. Advanced Technology
Development

performance of downsized satellites, reduce the acquisition leadtime and cost of such satellites, and develop affordable means to insert future technology or architecture into existing satellite designs.

(U) The Global Grid project will develop and demonstrate advanced communications technologies needed for defense and intelligence operations for the 21st century. The ultimate goal is deployment of a gigabit network that will be interoperable with commercial, optical and secure wireless networks.

This program element also includes efforts in Land Warfare, ASW, Unmanned Undersea Vehicles, Alternative Power Sources, and Advanced Guidance/Targeting Technologies.

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FY 1995-1996 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #06032226E Project Number: EE-21 Date: September 1993
PE Title: Experimental Evaluation of Budget Activity: 2. Advanced Technology Development
Major Innovative Technologies

A. (U) RESOURCES: (\$ In Thousands)

Project Title: Advanced Land Systems											
Popular Name	FY 1993 Actual	FY 1994 Estimate	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	To Complete	Total Program		
EE-21											
Advanced Land Systems											
*(8,993)	** (4,523)	27,750	33,750	44,060	53,960	48,282	Continuing	Continuing			

* FY93 funds for Speakeasy were funded in PE 0603737D, Balanced Technology Initiative.

**FY94 funds and program accomplishments for Speakeasy are funded in PE 0602702E, TT-07, Tactical Technology.

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: This project is intended to extend the information revolution to the land battlefield and make it a force multiplier in an era of reduced force structure. It capitalizes on advanced commercial technologies and applies them to continuing military challenges in the new global context. These tools will provide radically enhanced situational awareness, proactive artificial intelligence decision aids, and flexible communications to leverage the capabilities of smaller forces, while making it easier for them to deploy to trouble spots worldwide at minimal cost. The project consists of three main efforts: The Battle Command Initiative, the Commercial Communications Technology Testbed, and the multi-band, multi-mode radio (Speakeasy). This program will perform system developments and demonstrations of technologies and concepts developed in the battle management program in TT-04.

(U) The Battle Command Initiative (BCI) program develops and demonstrates enabling technologies and systems to obtain a joint, real-time, multi-level, graphical view of the battlespace while providing planning, situation awareness, assessment, and response capabilities to all levels of command. BCI uses information management as a force multiplier for increased effectiveness and reduced casualties in land combat operations. Initial efforts will be

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FY 1995-1996 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603226E Project Number: EE-21 Date: September 1993
PE Title: Experimental Evaluation of Budget Activity: 2. Advanced Technology Development
Major Innovative Technologies

performed in conjunction with a multi-level distributed simulation developed in EE-37. Demonstrations and exercises will be performed to determine system effectiveness and trade-offs.

(U) The Commercial Communications Technology Testbed (C²T²) Program develops and demonstrates communications testbeds for evaluation of commercial communications products for military applications. The initial focus is on leveraging low-cost commercial communications developments to address dismounted soldier requirements and obtain insights for wider applications of commercial communications. Payoffs for this program are: reduced cost, improved communications, and the ability to influence commercial technology developments with military requirements.

(U) Speakeasy is a program to develop a multi-band, multi-mode programmable digital radio capable of communicating with a wide variety of existing military and civilian radios. Initially, this will allow front-line units to communicate across the services. As Speakeasy is proliferated, it will allow increased rates of data transfer to occur. This will improve data flow within and across Services and result in long-term cost savings.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program:

- (U) Complete software development of baseline waveforms for Phase I Speakeasy.
- (U) Complete development of baseline technologies for Speakeasy.
- (U) Initiate integration of the Speakeasy Advanced Development Module (ADM).
- (U) Initiate the development of advanced technology modules for insertion into the Speakeasy Advanced Development Module (ADM).

(U) FY 1994 Planned Program:

- (U) Continue the development of advanced technology modules (ATMs) for insertion into Speakeasy. (\$2.0M)
- (U) Complete integration of Speakeasy. (\$1.5M)

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FY 1995-1996 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603226E Project Number: EE-21 Date: September 1993
PE Title: Experimental Evaluation of Budget Activity: 2. Advanced Technology Development
Major Innovative Technologies

- (U) Perform an initial advanced radio demonstration with the integrated Speakeasy radio. (1.0M)

(U) FY 1995 Planned Program:

- (U) Refine the BCI concept; begin development of key technologies for an advanced decision aid, multi-level situation awareness and distribute planning system and its associated communications, and begin fabrication of key component technologies. (\$7.7M)
- (U) C2T2: Conduct demonstrations of leveraged advanced civilian personal communications and computation technology in military operational training/test environment. (\$10.0M)
- (U) Speakeasy: Begin development of advanced system featuring enhanced interoperability with existing military radios. (\$10.0M)

(U) FY 1996 Planned Program:

- (U) BCI: Quantify results of technologies for advanced computational decision aids, multi-level data management and communications system. Integrate field exercises with key systems and subsystems. (\$14.7M)
- (U) C2T2: Transition advanced communications/computation equipment to Services. Further leverage civilian information management technologies for additional military applications to include low-cost communications for sensors and fire control systems. (\$9.0M)
- (U) Speakeasy: Continue development of advanced multi-band, multi-mode radio. (10.0M)

(U) Program to Completion:

- (U) Integrate successful technologies and subsystems into a joint, multi-level battle management system. Demonstrate the system in a joint operations exercise.
- (U) Complete development of the Speakeasy radio.

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FY 1995-1996 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603226E Project Number: EE-21 Date: September 1993
PE Title: Experimental Evaluation of Budget Activity: 2. Advanced Technology Development
Major Innovative Technologies

D. (U) WORK PERFORMED BY: The major performers include MITRE, Boston, MA and Washington, DC; Standard Research Institute, Menlo Park, CA; Harris Technologies, Arlington, VA; Bolt Beranek and Newman, Boston, MA; and Army Communications/Electrics Command, Ft. Monmouth, NJ.

E. (U) COMPARISON WITH FY 1994 DESCRIPTIVE SUMMARY: Not applicable. No FY 1994 Descriptive Summary.

F. (U) PROGRAM DOCUMENTATION: Not applicable.

G. (U) RELATED ACTIVITIES: Close Combat Technology developed under Program Element 0602702E and, Advanced Simulation developed under Program Element 0603226E.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: None.

J. (U) MILESTONE SCHEDULE:

Plan	Milestones
Sep 95	Initial demonstrations of selected critical components and technologies for Battle Command Initiative.
Oct-Dec 95	Soldier testing of commercial communications systems for dismounted operations and assessment of alternative missions.
Mar 96	Critical design review of Phase II Speakeasy system.
Sep 96	Complete demonstrations of critical components for Battle Command Initiative.
Oct-Dec 96	Demonstrate novel advanced warfighting concepts using the commercial communications testbed.
Mar 97	Initial capability demonstration of Phase II Speakeasy.
Sep 97	Initial capability demonstration of Battle Command System.

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FY 1995-1996 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603226E Project Number: EE-21 Date: September 1993
PE Title: Experimental Evaluation of Budget Activity: 2. Advanced Technology Development
 Major Innovative Technologies

Mar 98	Concept demonstrations of system enhancements and novel concepts using information from Battle Command System to enhance fire control and asset management.
Oct-Dec 98	Field exercises using Battle Command System.
Sep 99	Final demonstrations of novel concepts using enhanced information management.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #06032226E
PE Title: Experimental Evaluation of Major Innovative Technologies
Project Number: EE-24 Date: September 1993
Budget Activity: 2. Advanced Technology Development

A. (U) RESOURCES: (\$ In Thousands)

Project Title: ASTOVL/CTOL Common Affordable Lightweight Fighter									
Popular Name	FY 1993	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	To	Total
	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Complete	Program
EE-24	ASTOVL/CTOL Common Affordable Lightweight Fighter								
	4,770	19,712	19,039	1,954	0	0	0	0	45,475

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: In response to a Department of the Navy desired operational capability, the ASTOVL/CTOL Common Affordable Lightweight Fighter project was originated by ARPA to jointly investigate the technical feasibility of designing a single engine lightweight, affordable aircraft to conduct missions currently performed by the AV-8B, F-16, and F/A-18. As envisioned, the aircraft would be of modular design, providing for an Advanced Short Takeoff, Vertical Landing (ASTOVL) variant for use by the Navy and Marine Corps, and a Conventional Takeoff and Landing (CTOL) variant for use by the Air Force. These variants would share a common engine, airframe and avionics. The ASTOVL enabling propulsive lift system would be removed from the Air Force variant and replaced with additional fuel capacity. Major performance goals for the operational aircraft and demonstrator include: Weight Empty: <24,000lb; Size: <F-18C; Powerplant: (Single Engine) Derivative of the F-119 or YF-120 Advanced Tactical Fighter Engine (ATFE) augmented in the STOVL variant by a shaft or gas-driven lift fan; maneuvering and airspeed flight envelope equal to or greater than the F-18; Flyaway cost: <F-18C.

(U) The program consists of four phases. Phase I, which has been completed, investigated propulsive lift concepts. Phase II will validate critical technologies relevant to the two most promising propulsive lift concepts. ARPA has awarded two Phase II contracts, each investigating a different augmented lift concept. Each contract will address the system design and operational performance potential of a particular concept. This will be accomplished by performing system

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603226E
PE Title: Experimental Evaluation of Major Innovative Technologies
Project Number: EE-24 Date: September 1993
Budget Activity: 2. Advanced Technology Development

design and capability goal trade-off analyses. Additionally, this effort will explore the critical powered lift transition corridor using large scale model demonstrations. Full or large scale demonstrations of selected critical propulsion components will similarly be required. The degree of hardware development difficulty and hardware manufacturability will be analyzed, and where practical proven, in parallel with maturation of the aircraft design. The goal of this approach is not just to show that traditional engineering and manufacturing methods can be employed to produce the proposed design, but more importantly, to encourage developing and proving innovative processes for reducing engineering and manufacturing costs. If Phase II is successful, a single propulsive lift concept will be selected and Phase III will consist of design and fabrication of a full-scale technology demonstrator aircraft. Phase IV will consist of flight testing of the demonstrator aircraft.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program:

- Begin Critical Technology Validation (Phase II) of the project.
- Award two contracts: one to investigate the Shaft Coupled Lift Fan Concept and another to investigate the Gas Coupled Lift Fan Concept.
- Conduct operational aircraft concept design trade studies.

(U) FY 1994 Planned Program:

- Conduct affordability demonstrations, construct large scale wind tunnel models, and construct large scale propulsion system components for rig testing for the Shaft Coupled Lift Fan Concept.
- Conduct affordability demonstrations, construct large scale wind tunnel models, and construct large scale propulsion system components for rig testing for the Gas Coupled Lift Fan Concept.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603226E

PE Title: Experimental Evaluation
of Major Innovative
Technologies

Project Number: EE-24

Date: September 1993

Budget Activity: 2. Advanced Technology Development

(U) FY 1995 Planned Program:

- Commence large scale wind tunnel tests and large scale propulsion system tests for the Shaft Coupled Lift Fan Concept.
- Commence large scale wind tunnel tests and large scale propulsion system tests for the Gas Coupled Lift Fan Concept.

(U) FY 1996 Planned Program:

- Complete Critical Technology Validation of the Shaft Coupled Lift Fan Concept.
- Complete Critical Technology Validation of the Gas Coupled Lift Fan Concept.

(U) Program to Completion:

- Conduct Phases III and IV of the ASTOVL/CTOL Common Affordable Light Weight Fighter program. This is a continuing program.

D. (U) WORK PERFORMED BY: Contracted work is being performed by Lockheed Advanced Development Company, Palmdale, CA and McDonnell Douglas Aerospace, St. Louis, MO. NASA Ames Research Center, Moffett Field, CA is providing technical support.

E. (U) COMPARISON WITH FY 1994 DESCRIPTIVE SUMMARY: No changes.

F. (U) PROGRAM DOCUMENTATION:

- Joint ARPA/U.S. Navy project established by Memorandum of Agreement (MOA) dated 16 March 1993.
- Joint ARPA/NASA project established by Memorandum of Agreement (MOA) dated 4 June 1993

G. (U) RELATED ACTIVITIES: Program Element: 0603217N (Air Systems Advanced Technology Development).

H. (U) OTHER APPROPRIATION FUNDS: None.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #06032226E

PE Title: Experimental Evaluation
of Major Innovative
Technologies

Project Number: EE-24

Budget Activity: 2. Advanced Technology Development

Date: September 1993

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not Applicable

J. (U) MILESTONE SCHEDULE:

Planned	Milestones
Apr 94	Model Designs Complete
Apr 95	Model Fabrication Complete
Jul 95	Commence Wind Tunnel Test
Mar 96	Phase II Final Report
Apr 96	Decision to proceed with Phase III

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603226E
 PE Title: Experimental Evaluation of
 Major Innovative Technologies
 Project Number: EE-27 Date: September 1993
 Budget Activity: 2. Advanced Technology Development

A. (U) RESOURCES: (\$ In Thousands)

Project Title: Advanced Space Technology Program		FY 1993		FY 1994		FY 1995		FY 1996		FY 1997		FY 1998		FY 1999		Total	
Popular	Name	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Program
EE-27	Advanced Space Technology Program	14,711	30,213	11,435	11,944	12,014	4,031	7,745	Continuing	Continuing	Continuing	Continuing	Continuing	Continuing	Continuing	Continuing	Continuing

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENTS AND SYSTEM CAPABILITIES: The Advanced Space Technology program (ASTP) is aimed at achieving an affordability breakthrough in the development, launch and operation of satellite systems. To date, the goals have been to: demonstrate low cost access to space with small launch vehicles; reduce the size, weight, power and cost of satellite components and demonstrate first-generation lightweight satellite capabilities. This phase has formed a prerequisite technology foundation and has produced two new launch vehicles (the Pegasus Air-Launched Vehicle and the Taurus Standard Small Launch Vehicle), 10 small satellites and numerous advanced, miniaturized components.

(U) IMPACT is a multidisciplinary development program aimed at leveraging advanced technologies to reduce the life-cycle costs of all military satellite communications (MILSATCOM) terminals with associated reductions in size, weight and power consumption of MILSATCOM terminals and increased performance, reliability and capabilities. The program addresses broad technology efforts that span all MILSATCOM terminal programs with technology initiatives in support of next-generation terminals.

(U) The themes and objectives of the IMPACT program will benefit all MILSATCOM terminals as well as many commercial products. These themes include affordability (personnel cost avoidance through autonomous operation), interoperability (simultaneous multimode, multiband operations), mobility (via miniaturization) and high-performance capabilities (very high data rate

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603226E Project Number: EE-27 Date: September 1993
PE Title: Experimental Evaluation of Budget Activity: 2. Advanced Technology Development
Major Innovative Technologies

across all terminal classes (fixed-site, mobile, manpack, airborne, shipborne, etc.)

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program:

- (U) Completed satellite component technology developments.
- (U) Supported space demonstration of component technologies.
- (U) Transitioned Pegasus Air-Launched Vehicle to the Air Force.
- (U) Continued preparation for the launch of Taurus.
- (U) Completed the DARPA SAT satellite for launch on Taurus.
- (U) Initiated the IMPACT program.

(U) FY 1994 Planned Program:

- (U) Initiate development of the ATSSB. (\$9.8M)
- (U) Initiate contract for the EHF payload technologies for ASTEC. (\$2.2M)
- (U) Continue technology development for IMPACT. (\$3.2M)
- (U) Develop and assess multispectral sensor technologies under CAMEO. (\$15.0M)

(U) FY 1995 Planned Program:

- (U) Continue technology developments for IMPACT; conduct technology design reviews. (\$11.4M)

(U) FY 1996 Planned Program:

- (U) Continue technology developments for IMPACT; initiate subsystem/component fabrication. (\$11.9M)

(U) Program to Completion:

- (U) Continue the IMPACT program and award testbed terminal contracts.

D. (U) WORK PERFORMED BY: Orbital Sciences Corporation, Fairfax, VA; Space Applications

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603226E

Project Number: EE-27 Date: September 1993

PE Title: Experimental Evaluation of
Major Innovative Technologies

Budget Activity: 2. Advanced Technology Development

(U) Program to Completion:

- (U) Continue the IMPACT program and award testbed terminal contracts.

D. (U) WORK PERFORMED BY: Orbital Sciences Corporation, Fairfax, VA; Space Applications Corporation, Vienna, VA; EMS Technologies, Inc., Norcross, GA; Ball Aerospace Corporation, Boulder, CO; Honeywell, Minneapolis, MN; Hughes Space and Communications, Los Angeles, CA; Phillips Laboratory, Kirtland Air Force Base, NM; Rome Laboratory, Rome, NY; Air Force Space and Missile Systems Center, Los Angeles, CA; Western Test Range, Vandenberg Air Force Base, CA; and others.

E. (U) COMPARISON WITH FY 1994 DESCRIPTIVE SUMMARY: No change.

F. (U) PROGRAM DOCUMENTATION:

- (U) U.S. Air Force/ARPA MOA dated 1988
- (U) U.S. Army/ARPA MOA dated 1990
- (U) SDIO/ARPA MOA dated 1990
- (U) ARPA/U.S. Air Force TAOS MOA dated 1992

G. (U) RELATED ACTIVITIES: ARPA has MOAs with the Army, Navy, Air Force, BMDO (SDIO) and others for ARPA space technology projects.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. (U) MILESTONE SCHEDULE:

Plan	Milestones
Dec 93	First launch of Taurus (SSLV)/DARPA SAT.
Dec 93	Award contracts for IMPACT.
Jan 94	Transition the Taurus launch vehicle to the Air Force.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603226E Project Number: EE-27 Date: September 1993

PE Title: Experimental Evaluation of
Major Innovative Technologies Budget Activity: 2. Advanced Technology Development

Mar 94	Award contracts for the ATSSB and critical payload elements for ASTEC.
Aug 94	Complete demonstration of DARPASAT.
Nov 94	Transition the DARPASAT to user.
Dec 95	Complete IMPACT Design Reviews.
Dec 96	Complete fabrication of IMPACT hardware.
Aug 97	Award contract for IMPACT testbed terminal.
Jun 99	Complete IMPACT Testbed Terminal fabrication.
Sep 99	Complete IMPACT Testbed Terminal demonstrations.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603226E
 PE Title: Experimental Evaluation of Major Innovative Technologies
 Project Number: EE-34 Date: September 1993
 Budget Activity: 2. Advanced Technology Development

A. (U) RESOURCES: (\$ In Thousands)

Project Title: Guidance Technology																	
Popular		FY 1993		FY 1994		FY 1995		FY 1996		FY 1997		FY 1998		FY 1999		Total	
Name		Actual		Estimate		Estimate		Estimate		Estimate		Estimate		Estimate		Complete Program	
EE-34																	
Guidance Technology																	
13,260		6,329		10,907		18,937		16,000		15,000		0		0		87,381	

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENTS AND SYSTEM CAPABILITIES: Fire-and-Forget stand-off weapons need precise targeting information if time-critical fixed and mobile targets are to be eliminated effectively and with minimal collateral damage. This requires that: (1) military surveillance and targeting systems geo-locate targets accurately in the same targeting grid that the weapon system navigates in; (2) the weapon system has a precision navigation and guidance system on-board, plus an effective endgame seeker; and (3) both capabilities operate day/night and in adverse weather. In addition, future systems designed to accomplish this capability must be significantly more affordable. The achievement of these characteristics in an integrated system based on advanced navigation and guidance technologies is the goal of this program.

(U) This project develops and exploits the emerging affordable technologies in miniature Global Positioning System (GPS) receivers (MGRs); all solid-state gyroscopes and accelerometers; and miniature atomic clocks, to facilitate the desired precision targeting and weapon delivery concept (Common Grid). Specific research areas include the following: (1) advanced all solid-state, low-cost navigation-grade, interferometric fiber optic gyroscope (IFOG) miniature inertial measurement units (MIMUs); (2) multi-channel-on-a-chip, high-dynamics MGRs; (3) low cost differential GPS local broadcast stations; and (4) affordable endgame seeker technologies.

(U) The GPS Guidance Package (GGP) tightly integrates a MGR, and a MIMU with an advanced navigation computer into a potentially low-cost, precision navigation system. GGP Phase 1 addresses the technology issues involved in: (1) miniaturizing inertial-grade IMUs into a

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Program Element: #06032226E
PE Title: Experimental Evaluation of
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Project Number: EE-34 Date: September 1993
Budget Activity: 2. Advanced Technology Development

compact, manufacturable configuration; and (2) developing a multi-channel-on-chip, high dynamics MGR. Upon successful demonstration of these technologies they will be integrated into a brassboard for field testing and evaluation by ARPA and the Service elements. Phase 2 will demonstrate the compact affordable packaging of these technologies into a form compatible with a large range of unmanned and manned platforms, satellites and weapon systems. GGP Phase 2 units will meet more stringent environmental requirements and have a lower cost.

(U) Common Grid improves the standard GPS world-wide accuracy to less than 3 meters in location and 15 nanoseconds in time over a battlefield service area with a diameter exceeding 100 kilometers. Common Grid supplements the primary GPS system (on a non-interference basis), with a set of portable, theater deployed, battlefield-wide precision differential GPS (DGPS) transmitters providing broadcast service to authorized high dynamic users. The portable DGPS reference station combines an advanced, precise-service, GPS receiver with (1) a miniature tactical atomic clock, (2) a geo-physics self surveying software suite with a micro-processor, (3) communications equipment for networking and (4) a low power broadcast transmitter. Authorized users combine their standard GPS data with the Common Grid geo-reference broadcast data to achieve a WGS-84 precision refinement of their current location on the common grid.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program:

- (U) Fabricated MGR and MIMU hardware components and conducted subassembly test.
- (U) Coded software modules and began debug.
- (U) Conducted bench tests of GGP subsystems.
- (U) Developed multi-function self-aligned gate technologies.

(U) FY 1994 Planned Program:

- (U) Complete GPS system integration and benchtest. (\$3.9)
- (U) Initiate fabrication of the two AF GGP brassboards. (\$.4M)
- (U) Deliver GGP Phase 1 brassboards for government testing. (\$.6M)

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603226E Project Number: EE-34 Date: September 1993
PE Title: Experimental Evaluation of
Major Innovative Technologies Budget Activity: 2. Advanced Technology Development

- (U) Initiate contract to further reduce GGP in size, weight, power drain and cost. (\$1.4M)

(U) FY 1995 Planned Program:

- (U) Complete Government laboratory and field evaluations of GGP brassboards. (\$1.5M)
- (U) Complete fabrication of AF GGP brassboards and deliver for field testing.
- (U) Continue GGP Phase 2. (\$4.7M)
- (U) Conduct GGP Phase 2 critical component tests and preliminary design review. (\$1.7M)
- (U) Design Common Grid elements and demonstrate critical subsystem feasibility. (\$3.0M)

(U) FY 1996 Planned Program:

- (U) Continue GGP Phase 2. (\$4.7M)
- (U) Conduct GGP Phase 2 critical component tests and Critical Design Review. (\$1.7M)
- (U) Initiate fabrication of GGP Phase 2 brassboards. (\$6.5M)
- (U) Initiate development of Common Grid system brassboards for portable reference broadcast stations and user equipment adjuncts. (\$6.0M)

(U) Program to Completion:

- (U) Complete GGP Phase 2.
- (U) Complete and demonstrate precision targeting and weapon delivery using developed technologies in the Common Grid Architecture.

D. (U) WORK PERFORMED BY: NRad, San Diego, CA; Charles Stark Draper Laboratory, Boston, MA; RAND Corporation, Washington, DC; Galaxy Scientific Corporation, Philadelphia, PA; Litton Industries, Woodlawn Hills, CA; and Rockwell International, Collins Division, Cedar Rapids, IA.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #06032226E Project Number: EE-34 Date: September 1993
PE Title: Experimental Evaluation of Budget Activity: 2. Advanced Technology Development
Major Innovative Technologies

E. (U) COMPARISON WITH FY 1994 DESCRIPTIVE SUMMARY: Not applicable.

(U) Technical Changes: Common Grid initiative added.

F. (U) PROGRAM DOCUMENTATION: None.

G. (U) RELATED ACTIVITIES: The Air Force is jointly funding GGP Phase 1 from PE 0602204F, Avionics, and PE 0603311F, Ballistic Missile Technology. No other organizations are developing and integrating technologies for high-precision, tightly-coupled, advanced solid-state MIMU/MGR equipment. In addition, ARPA is developing low-cost seeker technologies and improved methods for low cost Interferometric Fiber Optic Gyroscope (IFOG) manufacturability using funds from Electronic Manufacturing Technology, PE 0603739E.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. (U) MILESTONE SCHEDULE:

<u>Plan</u>	<u>Milestones</u>
Mar 94	Phase 1 Brassboard Delivery
Mar 94	Government Brassboard Tests Begin
Jul 94	GGP Phase 2 Award
Jul 95	GGP Phase 2 Preliminary Design Review
Mar 96	GGP Phase 2 Critical Design Review
Jul 97	Phase 2 Contractor Testing
Mar 98	Phase 2 Brassboard Delivery
Mar 98	Government Brassboard Tests Begin

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603226E Project Number: EE-36 Date: September 1993
 PE Title: Experimental Evaluation of Budget Activity: 2. Advanced Technology Development
 Major Innovative Technologies

A. (U) RESOURCES: (\$ In Thousands)

Project Title: Advanced Anti-Submarine Warfare (ASW) Technology									
Popular	FY 1993	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	To	Total
Name	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Complete	Program
EE-36	ASW Technology	10,721	13,680	18,385	18,692	18,496	22,614	23,550	Continuing Continuing

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: The most likely environment in which Anti-Submarine Warfare will be conducted has changed from the deep ocean to shallow water (littoral warfare). Consequently, the focus of this project has shifted from examining innovative technologies for operations in the deep ocean to those employed in acoustically complex shallow water. This project develops technologies that will significantly enhance naval and maritime capabilities in littoral warfare environments.

(U) The project focuses on three areas of development: undersea sensor technology, ASW scene management, and periscope detection. The Undersea Sensor Technology project demonstrates applications of advanced object detection, classification, and localization technologies using high performance computing (HPC). In particular, this area focuses on demonstrating automatic target detection, localization, and tracking algorithms in distributed active and passive sensors. Efforts in this area will also produce a demonstration of multi-sensor fusion through automatic detection and classification algorithms for combining non-acoustic sensor data with both active and passive acoustic data; and provide a capability to display, geographically, a complete description of the maritime tactical scene. In addition, vertically directive low frequency sources of both a continuous and impulsive nature will be developed and demonstrated. The ASW scene management project will develop signal processing techniques to integrate real-time information with background intelligence to provide a complete picture of the

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603226E
PE Title: Experimental Evaluation of
 Major Innovative Technologies
Project Number: EE-36 Date: September 1993
Budget Activity: 2. Advanced Technology Development

shallow water operational situation. In the Periscope Detection project, the usefulness of advanced radar techniques, including ultra-wideband radar signals, for periscope detection will be determined.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program:

- (U) Automated multi-sensor processing in a synthetic environment.
- (U) Automated submarine active/passive sonar demonstration.
- (U) Advanced Sonar Processing System (ASPS): Provided a single operator sonar station permitting staff reduction.
- (U) Acoustic Time Series Simulator (ATSS): Extended high-fidelity design to include multiple receiver platforms.
- (U) Characterized detection, classification, and localization performance in a shallow water environment.
- (U) Continued implementation of adaptive shallow water algorithms.
- (U) Continued development of low frequency acoustic sources for employment from tactical aircraft and ships.
- (U) Autonomous Target Acquisition and Relocalization System (ATARS): Implemented a real-time, fully autonomous, 24-channel, full Directional Fixing and Ranging sonobuoy (DIFAR) system for Extended Echo Ranging (EER) application (automated detection, clutter rejection, localization, tracking).
- (U) Completed design of cooperative multi-static/multi-sensor fusion algorithm.
- (U) Conducted initial data collection and analysis for determining the exploitability of periscope resonance to wideband radar signals.
- (U) Conducted concept studies of alternative methods of radar periscope detection.

(U) FY 1994 Planned Program:

- (U) Develop sensors and arrays for shallow water environment. (\$6.0M)
- (U) Develop and conduct at-sea testing of an active acoustic system for shallow water

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603226E

PE Title: Experimental Evaluation of

Major Innovative Technologies

Project Number: EE-36

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- environments employing receiving arrays of various configurations and locations (multistatic active acoustic system). (\$1.2M)
- (U) Conduct at-sea wideband radar experiment for periscope detection. (\$.9M)
- (U) Initiate the development of shallow water total scene management system that provides the operational commander with complete information on the tactical, acoustical, and bathymetric conditions of the area of operations. (\$1.3M)
- (U) Develop and conduct testing of low frequency (LF) acoustic sources. (\$4.3M)

(U) FY 1995 Planned Program:

- (U) Complete system design/development of sensors and arrays for shallow water environment. (\$4.2M)
- (U) Conduct follow-on, at-sea testing of an active acoustic system for the shallow water environment with algorithms previously developed. (\$.7M)
- (U) Demonstrate directional source technology for diesel submarine detector. (\$4.6M)
- (U) Conduct at-sea testing for new transducer array. (\$2.4M)
- (U) Complete periscope detection development/laboratory demonstration. (\$1.3M)
- (U) Complete design of periscope detection system. (\$1.8M)
- (U) Complete Anti-Submarine Warfare (ASW) scene management system design. (\$2.7M)
- (U) Conduct ASW scene management system proof-of-concept demonstration. (\$.7M)

(U) FY 1996 Planned Program:

- (U) Complete system improvements of sensors and arrays for shallow water environment. (\$9.4M)
- (U) Conduct at-sea testing of periscope detection system. (\$3.0M)
- (U) Complete Anti-Submarine Warfare (ASW) scene management system development. (\$6.3M)

(U) Program to Completion: This is a continuing program.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603226E

Project Number: EE-36 Date: September 1993

PE Title: Experimental Evaluation of
Major Innovative Technologies

Budget Activity: 2. Advanced Technology Development

D. (U) WORK PERFORMED BY: Arete Associates, San Diego, CA; BBN Systems and Technologies, Arlington, VA; Raytheon Company, Portsmouth, RI; SRI International, Arlington, VA; ORINCON Corporation, San Diego, CA.

E. (U) COMPARISON WITH FY 1994 DESCRIPTIVE SUMMARY: No change.

F. (U) PROGRAM DOCUMENTATION: Not applicable.

G. (U) RELATED ACTIVITIES: This program has been fully coordinated with the following programs to ensure no duplication of effort:

- (U) Surveillance, signal processing and acoustic science technology are being developed under Program Element 0602702E, Tactical Technology.
- (U) Supporting high performance computing efforts are ongoing under Program Element 0602301E, Computing Systems and Communications.
- (U) Acoustic Signal Processing efforts are being pursued under Program Element 0602702E, Tactical Technology.
- (U) Navy Enhanced Advanced Technology Demonstration (EATD) (Shallow Water Technology Initiative), Program Element 0603555N.
- (U) Navy Advanced Anti-Submarine Warfare (ASW) Technology, Program Element 0603747N.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. (U) MILESTONE SCHEDULE:

Plan	Milestones
Aug 94	Conduct multistatic active/passive system testing demonstration in a shallow water environment.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603226E

PE Title: Experimental Evaluation of
Major Innovative Technologies

Project Number: EE-36

Date: September 1993

Budget Activity: 2. Advanced Technology Development

Jun 94	Complete laboratory-scale testing of low frequency (LF) acoustic sources.
Jul 94	Complete resonance periscope detector feasibility testing.
Mar 95	Complete system design/development of sensors and arrays for shallow water environment.
Sep 95	Conduct at-sea testing of an active acoustic system for shallow water environment.
Sep 95	Conduct at-sea testing for new transducer array.
Jul 95	Complete design of periscope detection system.
Sep 95	Conduct Anti-Submarine Warfare (ASW) scene management system proof-of-concept demonstration.
Jul 96	Complete system improvements of sensors and arrays for shallow water environment.
Sep 96	Conduct at-sea testing of periscope detection system.
Jun 96	Complete ASW scene management system development.
Nov 97	Conduct final at-sea demonstration of an active acoustic system for shallow water environment.
Jul 97	Complete development and demonstration of adaptive arrays.
Nov 97	Conduct final at-sea demonstration of periscope detection system.
Jun 97	Conduct ASW scene management system at-sea demonstrations.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603226E

Project Number: EE-37 Date: September 1993

PE Title: Experimental Evaluation of
Major Innovative Technologies

Budget Activity: 2. Advanced Technology Development

A. (U) RESOURCES: (\$ In Thousands)

Project Title: Advanced Simulation									
Popular	FY 1993	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	To	Total
Name	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Complete	Program
EE-37	Advanced Simulation								
	43,443	55,993	80,368	76,897	40,675	65,003	54,978	Continuing	Continuing

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: The Advanced Distributed Simulation program develops advanced interoperable technologies to enable a distributed, seamless warfighting simulation environment at the weapon level of detail. The ultimate goal is to provide the tools and standards necessary to create, on demand, a robust synthetic theater of war capable of supporting the following functions: Joint/Service readiness training; Joint/Service Doctrine refinement and development; requirements analysis; design, prototyping and manufacturing; and contingency planning, operations, after action review, battle management simulation, and historical analysis. The focus is on the development and integration of key technologies such as environmental representation, Semi-Automated Forces, simulation scalability, communications (advanced networking) and data flow, range instrumentation, and computer image generation. As technologies mature, they will be demonstrated and tested in joint theater war exercises of increasing size, complexity and utility which includes all forms of tactical simulation on a seamless electronic battlefield.

(U) The environmental programs concentrate on the creation of the digital environments for simulation including terrain representation, weather and dynamic terrain. The semi-automated forces creates a scaleable computer-generated military force that is representative and behaviorally accurate. Scaleability investigates and develops technological solutions to create a network of interconnections capable of accommodating a wide range of simulation goals and network demands. The communications and data flow technology developments concentrates research and development in areas contributing to providing the communications infrastructure capable of

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603226E

Project Number: EE-37

Date: September 1993

PE Title: Experimental Evaluation of

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Major Innovative Technologies

supporting 100,000 entities interoperating with each other in real time. Battle Management simulation relates to the initiatives developing a distributed interactive simulation environment capable of situational awareness and planning representations facilitating evaluations of a multi-level, joint battle management system. The range instrumentation project addresses the problem of interfacing the real world to the synthetic environment. The computer image generation program (CIG) emphasizes the need for an order of magnitude increase in CIG performance along with an order of magnitude decrease in cost. The Integrated Product and Process Development Simulation provides a linked, distributed toolbox of simulation tools for concurrent engineering of land vehicles.

(U) The Advance Simulation Technology developments support the DDR&E Science and Technology Thrust Panel for Synthetic Environments.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program:

- (U) Demonstrated technical principles for development of technologies supporting networked interoperation representing 10,000 entities on the synthetic battlefield.
- (U) Continued development of rapid terrain database generation capability and commenced environmental representation research.
- (U) Completed critical mobile target technology simulation/development network testbed with six major sites.
- (U) Demonstrated initial prototype of semi-automated forces with adaptive behavior for developmental evaluation of experimental aviation systems.
- (U) Continued development of a simulation/rehearsal node integrated with a CINC-level C4I system.
- (U) Initiated engineering feasibility of a low cost computer image generator for virtual battlefield simulation.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603226E

Project Number: EE-37 Date: September 1993

PE Title: Experimental Evaluation of

Budget Activity: 2. Advanced Technology Development

Major Innovative Technologies

- (U) Demonstrated initial point-to-point gateways required to network instrumented real systems, ranges virtual simulators/simulations and constructive simulations.
- (U) FY 1994 Planned Program:
 - (U) Demonstrate expanded technologies supporting 10,000 entities on the synthetic battlefield, and the interoperation of higher-level aggregated simulation with company networks of individual platform level simulators and company/battalion-level intelligent automated forces. Produce test and field interim scaleability solutions supporting the synthetic theater of war. (\$7.0M)
 - (U) Demonstrate prototype rapid terrain generation system capability to produce 100K square mile terrain in 14 days, initiate environmental representation research. (\$4.2M)
 - (U) Demonstrate working semi-automated forces that are behaviorally accurate. (\$12.5M)
 - (U) Demonstrate interoperation of simulated warfighting environment with service C3I systems in large-scale simulated maneuver exercises. (\$.5M)
 - (U) Demonstrate integration of virtual warfighting simulation and instrumented ranges. (\$14.4M)
 - (U) Demonstrate interactivity of high performance aviation in virtual simulation. (\$2.0M)
 - (U) Initiate design of a realistic representation of component service command nodes and provide the mechanism to portray the influence of one command level on the actions of the subordinate formation. (\$14.1M)
 - (U) Demonstrate engineering feasibility of low cost computer image generators for virtual battlefield simulation. (\$1.0M)
 - (U) Initiate development of linked concurrent engineering simulation for integrated product and process development of land vehicles. (\$.3M)

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603226E

PE Title: Experimental Evaluation of Project Number: EE-37 Date: September 1993

Major Innovative Technologies Budget Activity: 2. Advanced Technology Development

(U) FY 1995 Planned Program:

- (U) Demonstrate in a joint theater of war simulation technologies supporting 10,000 entities as individuals on the synthetic battlefield and the interpretation of higher-level aggregated simulation with networks of individual platform level simulators coordinated with company/battalion level intelligent automated forces. Design, analyze and test solutions to creating a robust network interconnection to accommodate a wide range of local and wide area simulation. (\$10.4M)
- (U) Demonstrate working production model of a system capable of generating 100K square mile terrain in 7-14 days. Demonstrate prototype environmental representation with the simulate entities. (\$7.0M)
- (U) Develop a distributed command and control software simulation architecture capable of representing the influence of one command level on the actions of the subordinate formations. (\$8.0M)
- (U) Demonstrate working semi-automated force capable of accurately representing the full range of tactical aviation in a behaviorally accurate representation. (\$7.3M)
- (U) Demonstrate in Joint Synthetic Theater of War intelligent synthetic forces supporting seamless land/sea/air warfighting simulation environment capable of representing 10,000 entities operating with a high degree of realism, fully integrated and supporting service and joint operational concept. (\$21.2M)
- (U) Demonstrate integration of the virtual warfighting simulation and instrumented range for aviation and ground ranges. (\$6.0M)
- (U) Transition to the services embedded, interoperable simulation capability spanning virtual (networked simulators), constructive (aggregate-level wargames), and real systems. (\$4.0M)
- (U) Initiate production prototype of a low cost computer image generator. (\$2.4M)
- (U) Development/demonstrate an initial capability for distributed interactive simulates of planning and situation awareness functions to enable evaluation of battle management systems and human factors. (\$7.8M)

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #06032226E Project Number: EE-37 Date: September 1993
PE Title: Experimental Evaluation of Budget Activity: 2. Advanced Technology Development
Major Innovative Technologies

- (U) Develop databases for concurrent engineering workstation for integrated product and process design (IPPD) and begin demonstration with a selected land vehicle design. (\$6.3M)

- (U) FY 1996 Planned Program:
 - (U) Demonstrate and transition expanded information technologies supporting 100,000 entities as individuals on the synthetic battlefield, networking individual platform level simulators coordinated with company/battalion level intelligent automated forces, real and virtual entities. Develop solutions based on simulation and network driven characterization. (\$7.7M)
 - (U) Demonstrate working production model of a system capable of generating 100K square mile terrain in 7 days or less, demonstrate a robust environmental battlefield to include dynamic terrain, fog haze, battlefield obscuration, and diurnal effects. (\$1.3M)
 - (U) Demonstrate a robust simulation architecture supporting the representation of a distributed command and control structure portraying the influence of one command level on the actions of the subordinate formations. Demonstrate increasingly more sophisticated working semi-automated-force capable of accurately representing the full range of tactical forces on the battlefield. Develop a robust set of interface specifications capable of accommodating a variety of technical architectures which represent service unique command and operational features. (\$15.4M)
 - (U) Demonstrate in Joint Synthetic Theater of War intelligent synthetic forces supporting seamless land/sea/air warfighting simulation environment capable of representing greater than 100,000 entities operating with a high degree of realism, fully integrated and supporting service and joint operational concepts, retaining the arbitration of battle outcomes at the entity level of detail. (\$21.2M)
 - (U) Demonstrate integration of the virtual warfighting simulation and instrumented range for aviation and ground ranges. (\$13.7M)

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603226E

Project Number: EE-37

Date: September 1993

PE Title: Experimental Evaluation of

Budget Activity: 2. Advanced Technology Development

Major Innovative Technologies

- (U) Demonstrate production and fielding of low cost computer image generators capable of visually portraying a robust joint simulation of greater than 10,000 entities, environmental and battlefield effects. (\$5.5M)
- (U) Conduct exercises with the distributed interactive battle management simulation to quantify performance of a multi-node system and provide insight into the human factors and soldier intergration issues. (\$8.2M)
- (U) Demonstrate concurrent engineering applications of integrated product and process design (IPPD) on land vehicle design, and provide quantification of improvements. (\$3.9M)

(U) Program to Completion:

- (U) Demonstrate and transition the technologies capable of providing a seamless land/sea/air warfighting simulation environment capable of representing 100,000 entities operating with a high degree of realism, fully integrated and supporting service and joint operational concepts, retaining the arbitration of battle outcomes at the entity level of detail.
- (U) Transition to services embedded, interoperable simulation capability spanning synthetic forces, environmental representations, communications and data flow and system scaleability.
- (U) Demonstrate and transition to the services a semi-automated forces architecture that is robust, behaviorally accurate, and scaleable to all echelons of command.
- (U) Demonstrate and transition a software architecture capable of representing the full range of joint operations.
- (U) Update and refine the capability to simulate an environment capable of situational awareness and planning representations facilitating evaluations of battle management concept, and of evaluating utility of developments contributing to battle management concept systems.
- (U) Continue to apply concurrent engineering applications on land vehicle design, and provide quantifications of improvements.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603226E

Project Number: EE-37 Date: September 1993

PE Title: Experimental Evaluation of

Budget Activity: 2. Advanced Technology Development

Major Innovative Technologies

- (U) Continue concurrent engineering workstation development leading to an improved second generation systems simulation of a virtual proving ground and virtual factory.
- D. (U) WORK PERFORMED BY: Bolt, Baranek, and Newman, Cambridge, MA; Loral Advanced Distributed Simulation, Cambridge, MA; Los Alamos National Laboratory, NM; MITRE Corporation, McLean, VA; University of Michigan, Ann Arbor, MI; ETA Technologies, San Diego, CA; and NCCO³C, (NRaD) San Diego, CA.
- E. (U) COMPARISON WITH FY 1994 DESCRIPTIVE SUMMARY: No change.
- F. (U) PROGRAM DOCUMENTATION: MOAs with all DSI nodes which require classified capability.
- G. (U) RELATED ACTIVITIES: Related work in technology development is closely coordinated with the Defense Modeling and Simulation Office to ensure that unnecessary duplication does not occur; Close Combat Tactical Training, STRICOM; Tactical Combat Training System (TCTS), PMA205.
- H. (U) OTHER APPROPRIATION FUNDS: None.
- I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.
- J. (U) MILESTONE SCHEDULE:

	<u>Planned</u>	<u>Milestones</u>
	Mar 94	Demonstrate communications and data flow technologies supporting 10,000 weapon platforms as individual objects on the synthetic battlefield.
	Jun 94	Demonstrate real to virtual connectivity on instrumented ranges.
	Sep 94	Demonstrate improved intelligent automated forces.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #06032226E
PE Title: Experimental Evaluation of Major Innovative Technologies
Project Number: EE-37 Date: September 1993
Budget Activity: 2. Advanced Technology Development

Nov 94	Demonstrate in a joint theater of war a seamless land/sea/air warfighting simulation environment representing operation with a high degree of realism, fully integrated and supporting service and joint operational concept.
Mar 95	Demonstrate engineering feasibility of low cost computer image generation technology.
Sep 95	Demonstrate rapid terrain generation capability.
Sep 95	Demonstrate distributed multi-level joint command/control systems functionality.
Sep 95	Demonstrate working concurrent engineering toolbox for vehicle design.
Sep 96	Provide production prototype low cost computer image generator.
Sep 96	Provide results of concurrent engineering application for land vehicle.
Sep 96	Conduct Synthetic Theater of War Technology Demonstration.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603226E

Project Number: EE-39

Date: September 1993

PE Title: Experimental Evaluation of

Budget Activity: 2. Advanced Technology Development

Major Innovative Technologies

A. (U) RESOURCES: (\$ In Thousands)

Project Title: Unmanned Undersea Vehicle Systems

Popular Name	FY 1993 Actual	FY 1994 Estimate	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	To Complete	Total Program
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EE-39	UUV/Mine Countermeasures (MCM)	15,880	17,952	17,839	17,900	17,571	17,395	18,115	Continuing Continuing
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B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: The increasing stockpile of underwater mines and stealthy nuclear and non-nuclear submarines throughout the world present a threat in both littoral warfare and strategic warfare situations. The objective of the Unmanned Undersea Vehicle (UUV) Systems Project is to develop and demonstrate fully autonomous, maritime UUV systems for undersea warfare. Work is focused in three areas: mine countermeasures (MCM), deployable surveillance systems (DSS), and UUV enabling technologies.

(U) In the MCM area, the Autonomous Minehunting and Mapping (AMM) System is expanding the technical base established by the Mine Search System to demonstrate the capability to autonomously locate and classify mines with sufficient precision for detailed mine mapping and subsequent reacquisition by a neutralization system. This capability will also be applicable for commercial undersea environmental survey and sampling. Advanced minehunting technologies, including sonars and other non-acoustic sensors and small autonomous vehicles for mine countermeasures in the surf zone are under development. Technologies for underwater locomotion and robotic techniques for deep ocean work and work involving ocean structures are also being addressed.

(U) In the DSS area, a multi-sensor buoy system containing acoustic and non-acoustic sensors with an in-situ signal processing capability is being developed. An acoustic communications network that will intelligently link the sensors to a manned platform is under parallel

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Program Element: #0603226E

Project Number: EE-32 Date: September 1993

PE Title: Experimental Evaluation of
Major Innovative Technologies

Budget Activity: 2. Advanced Technology Development

development. These two systems will be integrated as an automated surveillance network rapidly deployable on UUVs and other platforms.

(U) Unmanned Undersea Vehicle (UUV) enabling technologies being addressed include underwater communications, compact advanced inertial sensors for precision navigation, and high energy density fuel cell power system that will provide range and endurance required for longer UUV missions.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program:

- (U) Provided vehicle modifications for at-sea testing of UUV systems.
- (U) Completed Mine Search System (MSS) mine survey demonstration and transitioned to Navy.
- (U) Developed automated mapping process.
- (U) Completed studies of technology for autonomous vehicle operations in surf zone.
- (U) Fabricated multi-sensor fusion testbed and developed fusion algorithms.
- (U) Developed initial acoustic communications network capability.
- (U) Demonstrated two full-size proton exchange membrane (PEM) fuel cell stacks with auxiliaries; demonstrated aluminum-oxygen cells and stacks of three and nine cells.
- (U) Demonstrated advanced acoustic communications between Unmanned Undersea Vehicles (UUVs).
- (U) Investigated potential for underwater magnetic communications.

(U) FY 1994 Planned Program:

- (U) Install and integrate vehicle subsystem modifications for Autonomous Minehunting and Mapping (AMM) system. (\$2.6M)
- (U) Investigate acoustic and non-acoustic technologies for advanced minehunting sonar. (\$0.1M)

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #06032226E Project Number: EE-39 Date: September 1993
PE Title: Experimental Evaluation of Budget Activity: 2. Advanced Technology Development
Major Innovative Technologies

- (U) Conduct at-sea AMM demonstration with UUV. (\$7.5M)
 - (U) Develop technology for small autonomous vehicles. Conduct design studies of miniaturized underwater vehicles and modes of locomotion. (\$0.5M)
 - (U) Conduct effectiveness modeling and simulation of multi-sensor network. (\$1.4M)
 - (U) Conduct multi-node acoustic communication network at-sea test. (\$1.1M)
 - (U) Test brassboard PEM fuel cell power plant; complete detailed design for at-sea testing in UUV. (\$3.8M)
 - (U) Conduct at-sea test of testbed magnetic communication system. (\$0.6M)
 - (U) Test atomic interferometer inertial sensor. (\$0.3M)
- (U) FY 1995 Planned Program:
- (U) Provide vehicle modifications for at-sea testing of Unmanned Undersea Vehicle (UUV) systems. (\$3.2M)
 - (U) Investigate technologies for support of special operations forces. (\$0.1M)
 - (U) Continue development of Autonomous Minehunting and Mapping (AMM) improved navigation, mapping, and optical imaging system; develop environmental data collection capability. (\$6.3M)
 - (U) Develop synthetic aperture sonar for increasing mine detection and classification ranges and minehunting area search rate. (\$2.1M)
 - (U) Demonstrate locomotion technologies for small autonomous vehicles. (\$1.3M)
 - (U) Conduct in-water test of functional multi-sensor prototype system. (\$1.5M)
 - (U) Continue six month in-water test of acoustic communications network. (\$0.5M)
 - (U) Test and evaluate fuel cell power system at sea in UUV. Transition technology to Navy. (\$2.3M)
 - (U) Conduct at-sea test of prototype magnetic communication system. (\$0.2M)
 - (U) Demonstrate atomic interferometer in various inertial sensor configurations. (\$0.3M)

- (U) FY 1996 Planned Program:
- (U) Provide vehicle modifications for at-sea testing of UUV systems. (\$3.1M)

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603226E Project Number: EE-39 Date: September 1993
PE Title: Experimental Evaluation of Budget Activity: 2. Advanced Technology Development
Major Innovative Technologies

- (U) Conduct at-sea test of AMM system, including environmental data collection capability. (\$4.0M)
- (U) Develop buried mine sensors for small autonomous vehicles. (\$2.5M)
- (U) Demonstrate miniaturized autonomous underwater vehicle. (\$1.4M)
- (U) Down-select to one contractor to continue prototype synthetic aperture sonar development. (\$3.2M)
- (U) Commence integration of multi-sensor surveillance system with acoustic communications network. (\$3.7M)

(U) Program to Completion: This is a continuing program.

D. (U) WORK PERFORMED BY: Charles Stark Draper Laboratory, Cambridge, MA; Applied Research Laboratory, University of Texas, Austin TX; Loral Defense Systems, Akron, OH; Lockheed Missiles and Space Systems, Sunnyvale, CA; Woods Hole Oceanographic Institution, Woods Hole, MA.

E. (U) COMPARISON WITH FY 1994 DESCRIPTIVE SUMMARY: No change.

F. (U) PROGRAM DOCUMENTATION: Not applicable.

G. (U) RELATED ACTIVITIES: The Navy has established an Unmanned Undersea Vehicles (UUV) Program Management Office (PMO 403) to transition these projects to the Navy.

H. (U) OTHER APPROPRIATION FUNDS: None

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. (U) MILESTONE SCHEDULE:

<u>Plan</u>	<u>Milestones</u>
Jun 94	Demonstrate brassboard atomic interferometer inertial sensor.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #06032226E
PE Title: Experimental Evaluation of
Major Innovative Technologies
Project Number: EE-39 Date: September 1993
Budget Activity: 2. Advanced Technology Development

Aug 94	Begin at-sea testing of autonomous minefield mapping system.
Sep 94	Complete brassboard fuel cell power plant demonstration.
Sep 94	Demonstrate acoustic communications network.
May 95	Demonstrate small autonomous prototype legged vehicle in surf environment.
Jun 95	Begin at-sea testing of integrated Unmanned Undersea Vehicle (UUV) fuel cell power system.
Sep 95	Complete atomic interferometer precision navigation sensor development.
Aug 96	Begin at-sea testing of prototype Autonomous Minehunting and Mapping (AMM) System.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603226E Project Number: EE-40 Date: September 1993
 PE Title: Experimental Evaluation of Budget Activity: 2. Advanced Technology Development
 Major Innovative Technologies

A. (U) RESOURCES: (\$ In Thousands)

Project Title: Critical Mobile Targets (WAR BREAKER)		FY 1993		FY 1994		FY 1995		FY 1996		FY 1997		FY 1998		FY 1999		Total	
Popular	Name	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Complete	Program
EE-40	Critical Mobile Targets (WAR BREAKER)	34,724	104,553	124,654	117,537	114,303	113,162	115,795	Continuing	Continuing	Continuing	Continuing	Continuing	Continuing	Continuing	Continuing	Continuing

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: Prosecution of time-critical fixed and mobile targets has long been a concern of the Services as evidenced by past efforts in the areas of Strategic Relocatable Targets and Smart Weapons. Our experience in Desert Storm has dramatically demonstrated our current inability to prosecute these targets, particularly Tactical Ballistic Missiles (TBMs). ARPA's WAR BREAKER program will develop advanced technology and systems to enable the detection, identification and prosecution of a wide range of high value, time-critical fixed and mobile targets including TBMs, mobile command posts, tanks and artillery. This project serves as the framework for maturing and integrating advanced technologies developed within the Advanced Targeting Technology Project (TT-05) under PE 0602702E and developing and demonstrating system concepts supporting the prosecution of these targets. Key areas include advanced surveillance, target acquisition, automatic target detection and recognition, automated intelligence correlation, battlefield management, information distribution and terrain data generation technologies. This project is part of the ARPA contribution to the DoD Advanced Technology Demonstrations within the Global Surveillance and Communications and Precision Strike DDR&E thrust areas.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

- (U) FY 1993 Program:
 - (U) Continued development of advanced automatic target detection/recognition (ATD/R) algorithms for specific application to advanced synthetic aperture radar (SAR) and moving target indicator (MTI) radar for both wide area and focused surveillance.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603226E

PE Title: Experimental Evaluation of Major Innovative Technologies

Project Number: EE-40

Date: September 1993

Budget Activity: 2. Advanced Technology Development

- (U) Continued concept designs of integrated surveillance system employing advanced MTI/SAR radar and multispectral EO/IR sensor.
- (U) Continued foliage penetration (FOPEN) radar technology development.
- (U) Completed system and subsystem hardware fabrication for the Multi-Sensor Target Recognition System (MUSTRS) Program.
- (U) Continued WAR BREAKER baseline concept development.
- (U) Continued WAR BREAKER systems studies incorporating initial distributed simulation system capability.
- (U) Continued development of 3-D Interferometric Radar (IFSAR) technology development.
- (U) Initiated Gamma-Gamma resonance imaging development.
- (U) Achieved terrain delimitation goal of providing reduced target search volumes with rapid turnaround.

(U) FY 1994 Planned Program:

- (U) Initiate tests on advanced MTI/SAR ATR/D algorithms. (\$3.8M)
- (U) Continue experiments designed to statistically validate advanced algorithms applicable to advanced target detection radars. (\$14.6M)
- (U) Conduct initial tests of 3-D digital terrain elevation (DTE) IFSAR. (\$3.0M)
- (U) Conduct MUSTRS captive flight tests. (\$8.5M)
- (U) Complete baseline development of WAR BREAKER distributed simulation system. (\$20.9M)
- (U) Begin development of low cost radar (LoCoR) technology. (\$5.7M)
- (U) Continue development of components/systems which extract, correlate, fuse and display intelligence information to determine changes in force status, order of battle, and operational doctrine of time critical targets. (\$20.5M)
- (U) Initiate development of dynamic intelligence processor and tracking functions for the Local Attack Controller (LAC). (\$11.4M)
- (U) Demonstrate technology to rapidly fuse and distribute historical intelligence database information. (\$12.2M)

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603226E Project Number: EE-40 Date: September 1993
PE Title: Experimental Evaluation of Budget Activity: 2. Advanced Technology Development
Major Innovative Technologies

- (U) Initiate algorithm development for multi-spectral and IFSAR processing for feature extraction and elevation data fusion and for real-time modification of theater terrain data. (\$3.9M)
- (U) FY 1995 Planned Program:
 - (U) Complete final development of WAR BREAKER distributed simulation system. Exercise distributed simulation and systems engineering tools in support of WAR BREAKER system development efforts and refinement of WAR BREAKER system concept. (\$18.0M)
 - (U) Continue development, test and integration of intelligence correlation components/systems to include force status assessment demonstration and test and integration of two single intelligence correlators with the multiple intelligence correlator. (\$20.0M)
 - (U) Continue development, test and integration of LAC components/systems to include a dynamic intelligence processor demonstration and a demonstration of Army-focused battle management technology. (\$12.4M)
 - (U) Continue development, test and integration of Multiple Access Intelligence and Nomination (MAINS) to include initiation of database linking capability and a concept demonstration of the mission nominator. (\$10.9M)
 - (U) Continue development, test and integration of the terrain and feature generator (TFG) system to include extraction, processing and registration of elevation from IFSAR and vegetation from multi-spectral imagery. (\$7.6M)
 - (U) Conduct wide-area surveillance experiments. (\$5.7M)
 - (U) Continue data analysis and evaluation of automatic target detection and recognition (ATD/R) (in conjunction with TT-05). (13.9M)
 - (U) Complete critical component development and test, and design of the low cost radar (LoCoR) and begin fabrication of brassboard. (\$21.7M)
 - (U) Complete test and evaluation of Multi-Sensor Target Recognition System (MUSTRS) Technology. (\$3.2M)
 - (U) Continue, analysis, design and development of a multi-spectral infrared sensor. (\$2.0M)
 - (U) Complete tests and evaluation of 3D digital terrain elevation IFSAR. (\$2.4M)

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603226E

PE Title: Experimental Evaluation of

Project Number: EE-40 Date: September 1993

Budget Activity: 2. Advanced Technology Development

Major Innovative Technologies

- (U) Continue development of an advanced targeting sensor testbed. (\$6.8M)

(U) FY 1996 Planned Program:

- (U) Continue to exercise distributed simulation and systems engineering tools in support of WAR BREAKER system development efforts and refinement of WAR BREAKER system concept. (\$17.0M)
- (U) Continue development, test and integration of intelligence correlation components to include final test and demonstration of the standalone message handling component and the first demonstration of integrated intelligence correlation subsystems. (\$19.6M)
- (U) Continue development, test and integration of LAC components to include demonstration of tracker integration and initiation of integration of all battle management subsystems. (\$12.6M)
- (U) Continue development, test and integration of MAINS components to include final demonstration of database generation components and installation of database generators at user test sites. (\$11.1M)
- (U) Continue development, test and integration of the terrain and feature generator to include demonstrating of fusion and update of transportation nets, features and drainage derived from different sources. (\$7.7M)
- (U) Continue evaluation of ATD/R algorithms (in conjunction with TT-05). (\$3.0M)
- (U) Continue fabrication and subsystem testing of the low cost radar (LoCoR). (\$29.0M)
- (U) Continue development of a multi-spectral infrared sensor for focused surveillance and targeting. (\$10.1M)
- (U) Continue fabrication of an advanced targeting sensor. (\$7.4M)

(U) Program to Completion:

- (U) Demonstrate advanced ATD/R algorithms for MTI/SAR radars.
- (U) Complete fabrication and test advanced, low-medium altitude target acquisition/prosecution system.

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Program Element: #0603226E

Project Number: EE-40 Date: September 1993

PE Title: Experimental Evaluation of
Major Innovative Technologies

Budget Activity: 2. Advanced Technology Development

- (U) Demonstrate improved unattended ground sensors (UGS) and the potential for an internetted UGS system.
- (U) Complete Ultra-Wideband (UWB) foliage penetration radar development.
- (U) Demonstrate capability to correlate all-source intelligence for detection, tracking, targeting, and destruction of Time Critical Targets (TCTs).
- (U) Demonstrate integrated intelligence correlation and battle management to facilitate local attack control.
- (U) Demonstrate technology to build and distribute over a wide area network, terrain and feature and intelligence and object data for a 1 million square KM theater.
- (U) Demonstrate technology for LoCoR.

D. (U) WORK PERFORMED BY: General Dynamics, Convair Division, San Diego, CA; Martin Marietta, Orlando, FL; ERIM, Ann Arbor, MI; Lincoln Laboratory, Lexington, MA; Texas Instruments, Dallas, TX; BDM International, McLean, VA; SAIC International, Arlington, VA; Sandia National Laboratory, Santa Fe, NM; Lockheed Missile Systems, Austin, TX; Atlantic Aerospace, Greenbelt, MD; Grumman Aerospace Corporation, Melbourne, FL; Logicon, San Pedro, CA; Booz, Allen and Hamilton, McLean, VA; Boeing Corp., Seattle, WA; Pacific Sierra Research, Santa Monica, CA; and others to be determined.

E. (U) COMPARISON WITH FY 1994 DESCRIPTIVE SUMMARY: No change.

F. (U) PROGRAM DOCUMENTATION: Not applicable.

G. (U) RELATED ACTIVITIES:

- (U) PE#0602702E, Project TT-05, Advanced Targeting Technology Project forms the technology base for the WAR BREAKER Project.

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PE Title: Experimental Evaluation of Project Number: EE-40 Date: September 1993
Major Innovative Technologies Budget Activity: 2. Advanced Technology Development

- (U) This project is a part of the ARPA contribution to the DoD Advanced Technology Demonstrations with the Global Surveillance and Communications and Precision Strike Thrust Areas. The specific projects have been coordinated and fully integrated with Army, Navy and Air Force plans to insure non-duplication and compatibility with the integrated demonstrations planned.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. (U) MILESTONE SCHEDULE:

Plan	Milestones
Mar 94	Complete MUSTRS captive flight test.
Feb 95	Complete WAR BREAKER distributed simulation.
Nov 95	Demonstrate automapping capability using IFSAR.
Nov 95	Initial demonstration of automatic cue development from contextual analysis of MTI radar data.
Nov 97	Demonstrate technology to build and distribute over a wide area network, terrain and feature and intelligence and object data for a 1 million square KM theater.
Nov 97	Demonstrate integrated intelligence correlation and battle management to facilitate local attack control.
May 98	Conduct integrated wide area/focused surveillance system demonstration.
Nov 98	Demonstrate capability to correlate all-source intelligence to detection, tracking, targeting, and destruction of time critical targets.
Sep 98	Demonstrate multi-spectral and IFSAR processing feature extraction and elevation data fusion and real-time modification of theater terrain data.
Jun 99	Conduct fully integrated WAR BREAKER demonstration.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #06032226E
 PE Title: Experimental Evaluation of Major Innovative Technologies
 Project Number: EE-41 Date: September 1993
 Budget Activity: 2. Advanced Technology Development

A. (U) RESOURCES: (\$ In Thousands)

Project Title: Air Defense Initiative (ADI)									
Popular Name	FY 1993	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	To	Total
	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Complete	Program
EE-41									
	ADI								
	*(32,018)	27,717	40,600	31,600	32,000	41,000	41,000	Continuing	Continuing

*Formerly funded in ADI PE 0603741D

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENTS AND SYSTEM CAPABILITIES: Air Defense Initiative programs form a critical part of the Advanced Research Project Agency's program to ensure defense against cruise missiles and manned aircraft. The programs also complement systems being pursued by other program offices to counter theater ballistic missile threats. The rapid evolution and spread of cruise missile systems and technologies require new approaches and technologies to ensure effective and efficient countering of future airbreathing threats to troops in regional theaters.

(U) The Mountaintop Program determines the limits of conventional sensors to combat stealthy targets and tests adaptive signal processing techniques for advanced airborne radars. It employs an existing Navy radar at an elevated ground-based location as a efficient surrogate for an airborne platform. The geographic location provides a real-world clutter and jamming environment. The program develops a phenomenology and propagation data base, develops advanced adaptive processing hardware and algorithms, and supports integrated tests.

(U) HAVE DUNGEON enhances the capability to provide data integration and identification techniques for aerospace defense. Advanced hardware and software are developed to exploit data provided by intelligence sensors and collateral surveillance systems to provide near-real-time warning, attack assessment, and track history for the engagement of hostile targets.

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Program Element: #0603226E

Project Number: EE-41 Date: September 1993
PE Title: Experimental Evaluation of Budget Activity: 2. Advanced Technology Development
Major Innovative Technologies

(U) The Simulation and Modeling Program investigates and demonstrates new air defense technologies and concepts, and their integration into theater force structure. It emphasizes and illustrates concepts to counter the cruise missile and other airbreathing threats, and allows warfighters to test and demonstrate technology concepts. The program interacts with the existing Air Force Theater Air Command and Control Simulator Facility and the Navy Weapons and Tactics Analyses Center for man-in-the-loop simulation exercises. Extension of the initial simulation environment will be with ARPA's WAR BREAKER Defense Distributed Simulation System.

(U) The Special Materials Analysis program is investigating a new class of absorption materials developed from coated microballoons to determine their effectiveness and utility for a broad spectrum of applications.

(U) The Airborne Infrared Measurement System (AIRMS) program will provide improved scientific understanding of the fundamental limits of infrared technologies and will develop analytical tools, models and design methodologies, and associated signal processing algorithms and architectures. The program employs the existing AIRMS testbed airborne infrared imaging sensor and aircraft to collect high resolution digital imagery of airborne vehicles, background clutter, clouds, and other phenomenonology.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program:

- (U) Mountaintop Program collected bi-static clutter data at White Sands Missile Range. This data will allow development of algorithms and hardware mitigating the effects of terrain enhanced jamming of airborne early warning platforms.
- (U) HAVE DUNGEON performed a counter cruise missile experiment integrating Navy acoustic data with NORAD air sensor data, and then delivered a prototype system for auto target recognition to 480th AIG at Langley AFB, VA.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603226E

PE Title: Experimental Evaluation of
Major Innovative Technologies

Project Number: EE-41 Date: September 1993
Budget Activity: 2. Advanced Technology Development

- (U) The Simulation and Modeling Program determined requirements, completed the development plan, and completed the initial compatibility and linkage with the Air Force Simulation Facility.
- (U) The Airship Program continued the YEZ-2A design.
- (U) The HAVE YAK program began brassboard design for a low risk, near term approach for sensing to counter cruise missiles. HAVE YAK transitions to Air Force in FY94.
- (U) The Special Materials Analysis program continued the investigation of a new class of absorption materials for increased system survivability and a significant reduction in cost.

(U) FY 1994 Planned Program:

- (U) The Mountaintop program will collect a multi-channel radar data base at White Sands Missile Range. This data base will be the first of its type and will allow the user community to develop and evaluate Space-Time Adaptive Processing (STAP) algorithms for airborne applications. (\$11.4M)
- (U) HAVE DUNGEON's Proof-of-Concept Aerospace Defense Location will participate in an interactive Theater Missile Defense wargame with Air Force and Navy simulation facilities, and will demonstrate the integration of overhead and undersea surveillance. (\$6.0M)
- (U) The Simulation and Modeling Program will develop a prototype system supporting both analyses and man-in-the-loop exercises, including a distributed exercise. (\$8.8M)
- (U) The Special Materials Analysis program will continue investigation of the microballoon absorbing materials, ensure strict materials processing controls, and perform specific comparisons of these new materials with existing absorbers. (\$1.5M)

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603226E
PE Title: Experimental Evaluation of
Major Innovative Technologies
Project Number: EE-41 Date: September 1993
Budget Activity: 2. Advanced Technology
Development

(U) FY 1995 Planned Program:

- (U) The Mountaintop program will move to the Pacific Missile Range Facility (PMRF) in Hawaii and begin collecting multi-channel radar data of advanced, low-flying targets in over-water and littoral environments. Emphasis will be on studying the impact of jamming and multipath on detection of sea skimming cruise missiles. (\$8.6M)
- (U) HAVE DUNGEON will establish the utility of integrated intelligence and conventional data source integration in the tactical environment. (\$6.0M)
- (U) The Simulation and Modeling Program will complete incorporation of ADI models in the simulation system. Man-in-the-loop exercises will address the value of new air defense technology concepts. (\$10.0M)
- (U) The Special Materials Analysis program will investigate additional coatings on the microballoon absorbing materials for increased system survivability. System designs will be prepared to demonstrate absorber performance. (\$2.0M)
- (U) The Airborne Infrared Measurement System (AIRMS) will perform initial target data collection flights, and begin evaluation of operational algorithms for target characterization and recognition. (\$14.0M)

(U) FY 1996 Planned Program:

- (U) The advanced Space-Time Adaptive Processing (STAP) Processor will be incorporated into the Mountaintop radar for breadboard evaluation. The STAP processor will be evaluated in terms of its potential for meeting the next-generation airborne radar requirements for the Services. (\$10.6M)
- (U) HAVE DUNGEON will incorporate new software advances to significantly decrease the timelines for response to ADI threats. (\$6.0M)
- (U) The Simulation and Modeling Program will hold distributed exercises and demonstrations to verify performance of concepts from EE-CLS/ADI program element. (\$10.0M)

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #06032226E

PE Title: Experimental Evaluation of

Major Innovative Technologies

Project Number: EE-41 Date: September 1993

Budget Activity: 2. Advanced Technology Development

- (U) The AIRMS will perform advanced target data collection flights, employ the data in the evaluation of algorithms, and perform near real time demonstrations with operational algorithms. (\$5.0M)
- D. (U) WORK PERFORMED BY: The primary contractors for the efforts are: Westinghouse Airships Inc., Baltimore, MD and Weeksville, NC; Lockheed, Fort Worth, TX; Geodynamics, Colorado Springs, CO; SenCom and MIT/Lincoln Laboratories, Bedford, MA; and SAIC, McLean, VA and San Diego, CA. USAF Rome Laboratories, USAF Electronic Systems Command, USAF Wright Laboratories, and Naval Air Warfare Center, Aircraft Division provide agent support.

E. (U) COMPARISON WITH FY1994 DESCRIPTIVE SUMMARY: The Special Materials Analysis program was not previously funded in EE-41.

F. (U) PROGRAM DOCUMENTATION: ADI Program Plan, August 1993.

G. (U) RELATED ACTIVITIES: The EE-41 air defense effort is coordinated with related air defense test and simulation efforts through the DDR&E Thrust Area (3) Manager. ADI is part of a larger air defense technology program that includes EE-CLS/ADI funds.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not Applicable.

J. (U) MILESTONE SCHEDULE:

Plan	Milestones
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Mountaintop Program:

Feb 94

Complete Space-Time Adaptive Processing (STAP) data base collection at White Sands Missile Range and initiate testing with advanced E-2C antenna.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #06032226E
PE Title: Experimental Evaluation of
Major Innovative Technologies
Project Number: EE-41 Date: September 1993
Budget Activity: 2. Advanced Technology
Development

Sep 94 Conduct sea-skimmer detection experiments at Pacific Missile Range Facility (PMRF).
Sep 96 Install the STAP processor with the Radar Surveillance Technology Experimental Radar at PMRF and initiate testing with advanced clutter and jamming rejection techniques.

Simulation and Modeling Program:

Jun 94 Conduct Simulation Program exercises with Air Force and complete ADI-specific RF and IR baseline models.
Aug 95 Complete two additional simulation baseline models and the prototype system.
Jul 96 Conduct distributed Air Defense Initiative exercises demonstrating new concepts from EE-CLS/ADI program element.

HAVE DUNGEON:

Apr 94 Perform interactive Theater Missile Defense wargame experiment.
Jun 95 Prototype the system in exercise or operational demonstration.
Feb 96 Demonstrate dramatically reduced timelines for response against ADI threats.

Special Materials Analysis Program:

Aug 94 Definitize materials process controls for initial coating.
Mar 95 Complete alternate coating materials process investigation, measurements and analysis.

Airborne Infrared Measurement System Program:

Aug 95 Perform the initial target data collection flights, and begin evaluation of operational algorithms for target characterization and recognition.
Jun 96 Perform advanced target data collection flights, employ the data in the algorithms, and perform near real time demonstrations with operational algorithms.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603226E
 PE Title: Experimental Evaluation of
 Major Innovative Technologies
 Project Number: EE-43 Date: September 1993
 Budget Activity: 2. Advanced Technology Development

A. (U) RESOURCES: (\$ In Thousands)

Project Title: Department of Defense Alternative Power Sources									
Number & Title	FY 1993 Actual	FY 1994 Estimate	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	To Complete	Total Program
EE-43									
Alternative Power Sources									
	54,539	0	10,000	14,488	24,514	30,000	30,000	Continuing	Continuing

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENTS AND SYSTEM CAPABILITIES: The survivability and lethality of future strategically deployable combat vehicles can be significantly improved by new drive train and propulsion technology. The solution requires hybrid electric drive systems that enable greater deployability, and mobility while providing the electric power demanded by advanced sensors, emerging weapons, and power-intensive survivability subsystems. The significant survivability and lethality improvements in future strategically-deployable vehicles are intrinsically tied to the use of hybrid electric drive. Hybrid electric drive component technology applies to both military (combat, tactical, and non-deployable) and commercial electric, hybrid, and natural gas vehicles. The Alternative Power Sources project supports the development of advanced electric, hybrid, and natural gas vehicles, components, and infrastructure technologies to enable both the armed forces and commercial sector to achieve mission objectives, energy cost savings, and comply with environmental requirements. Enabling hybrid electric drive technology developments will encompass power generation, energy storage, drive train, power controllers, ancillary systems, and composite structures. These technologies will provide military systems great flexibility in the location of drive elements, permit reduction in vehicle silhouette, signature, and volume under armor; as well as increase mobility and deployability. The resulting products, appropriately scaled, will also accelerate the "time-to-market" of advanced alternatively powered commercial vehicles at reduced cost. The Alternative Power Sources project builds upon the FY 1993 Congressional directed Electric and Hybrid Vehicle Technology, Infrastructure Demonstration Program and the Natural Gas Vehicle Program.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #06032226E
PE Title: Experimental Evaluation of
Major Innovative Technologies
Project Number: EE-43 Date: September 1993
Budget Activity: 2. Advanced Technology Development

(U) The Electric and Hybrid Vehicle Technology and Infrastructure Demonstration Program will develop and insert advanced component technologies into a range of vehicles including lightweight pickup trucks, medium sized buses, lightweight four-wheeled tactical vehicles, six-wheeled medium armored vehicles, and fully-tracked combat vehicles. These vehicles will be used to demonstrate dual-use applications, reduced size, weight, and cost while increasing reliability and performance. Component manufacturing process will be analyzed and innovative processes will be developed to combine common military and commercial technologies for reducing engineering and manufacturing costs while establishing and maintaining a stable industrial base. The Natural Gas Vehicle Program will convert conventional non-tactical vehicles to natural gas and develop supporting infrastructure for testing on military installations to assess performance, life-cycle and energy cost savings, and environmental impact. Specific natural gas research areas include: multi-fueled auxiliary power units, storage, conversion devices, pumps and compressors, and sensors. Selected natural gas technologies will be integrated into hybrid electric tactical combat vehicles for primary power generation and non-tactical vehicles for range extension.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program:

- (U) Awarded grants and agreements to national coalitions for electric and hybrid vehicle development.
- (U) Developed advanced power generation, motor/controllers, and rapid charging component technologies.
- (U) Converted or fabricated electric and hybrid non-tactical pickup trucks and buses for military and commercial demonstrations.
- (U) Demonstrated electric drive on existing wheeled and tracked tactical combat vehicles.
- (U) Established natural gas conversion and infrastructure program with the Services.
- (U) Converted non-tactical vehicles to natural gas with infrastructure on military installations.
- (U) Developed and refined multi-fuel auxiliary power unit and conducted supporting natural gas component research.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #06032226E Project Number: EE-43 Date: September 1993
PE Title: Experimental Evaluation of Budget Activity: 2. Advanced Technology Development
Major Innovative Technologies

- (U) Conducted safety, environmental, and user acceptance analyses.
- (U) Assessed military and commercial user requirements for advanced component development.

(U) FY 1994 Planned Program: Not applicable.

(U) FY 1995 Planned Program:

- (U) Study flexible manufacturing and component cost reduction. (\$.6M)
- (U) Continue development of advanced electric and natural gas components and subsystems. (\$3.0M)
- (U) Integrate advanced components into demonstration vehicles. (\$2.5M)
- (U) Complete safety, environmental, and user acceptance analyses. (\$.3M)
- (U) Develop electric drive system for future tactical and combat vehicles. (\$3.6M)

(U) FY 1996 Planned Program:

- (U) Develop flexible manufacturing and component cost reduction capability. (\$.8M)
- (U) Develop scalability study for military and commercial alternative power source components. (\$.2M)
- (U) Continue electric, hybrid, and natural gas military and commercial vehicle demonstrations. (\$2.0M)
- (U) Continue development of advanced electric and natural gas components and subsystems. (\$4.0M)
- (U) Demonstrate integrated advanced component technology. (\$3.0M)
- (U) Continue electric drive system for future tactical and combat vehicles. (\$4.5M)

(U) Program to Completion:

- (U) Develop flexible manufacturing and component cost reduction capability.
- (U) Complete electric, hybrid, and natural gas military and commercial vehicle demonstrations.
- (U) Demonstrate scalable alternative power source components.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #06032226E Project Number: EE-43 Date: September 1993
PE Title: Experimental Evaluation of Budget Activity: 2. Advanced Technology Development
Major Innovative Technologies

- (U) Complete development of advanced electric and natural gas components and subsystems.
- (U) Demonstrate electric drive system on future tactical and combat vehicles.
- (U) Transition vehicles and technologies to military and commercial users.

D. (U) WORK PERFORMED BY: Northeast Alternative Vehicle Consortium, Boston, MA; Southern Coalition for Advanced Transportation, Atlanta, GA; Mid-America Electric Vehicle Consortium, Indianapolis, IN; CALSTART, Burbank, CA; Sacramento Municipal Utility District, Sacramento, CA; Hawaii Electric Vehicle Demonstration Project Consortium, Honolulu, HI; Southwest Research Institute, San Antonio, TX; Belvoir Research, Development, and Engineering Center, Fort Belvoir, VA; Southwest Division of Naval Facilities Command, San Diego, CA; U.S. Air Force Combat Support Division, Directorate of Supply; Carderock Division, Naval Surface Warfare Center, MD; Advanced Surface Machinery Programs, NAVSEA; U.S. Army Tank Automotive Command, Warren, MI; and Earth Conservancy, Wilkes-Barre, PA.

E. (U) COMPARISON WITH FY 1994 DESCRIPTIVE SUMMARY: Not applicable.

F. (U) PROGRAM DOCUMENTATION: Not applicable.

G. (U) RELATED ACTIVITIES: This program has been fully coordinated with the Departments of Defense, Energy, Transportation, Commerce, Interior, National Aeronautics and Space Administration, and Environmental Protection Agency to ensure that unnecessary duplication does not occur. The related Program Elements to the Alternative Power Sources project in DOD are: 0605896F - Base Operation RDT&E and 0603216F - Aerospace Technology Propulsion and Power (TriService/NASA More Electric Initiative). This program coordinates directly with Program element 0603739E - Electronics Manufacturing Technology (Design and Manufacturing) within ARPA.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603226E
 PE Title: Experimental Evaluation of
Major Innovative Technologies
 Project Number: EE-43 Date: September 1993
 Budget Activity: 2. Advanced Technology Development

J. (U) MILESTONE SCHEDULE:

Planned
 Sep 93
 Apr 94
 May 94
 May 94
 Apr 95
 Apr 95
 Jul 95
 Sep 95
 Apr 96
 Sep 96
 Sep 97
 May 98

Milestones

Electric and hybrid vehicle and technology coalition awards.
 Demonstrate electric and natural gas military and commercial vehicles.
 Demonstrate electric and hybrid military and commercial buses.
 Demonstrate converted tactical combat vehicle electric drive demonstrators.
 Military and commercial alternative power vehicle technology contract awards.
 Future tactical combat vehicle electric drive systems contract awards.
 Demonstrate component technology.
 Complete safety, environmental, and user acceptance analyses.
 Demonstrate advanced alternative power vehicles and component technologies.
 Critical design review for future tactical combat vehicle electric drive systems.
 Test Hybrid electric vehicles for technical and service requirements.
 Test reworked and improved integrated vehicles for technical and service test.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #06032226E

PE Title: Experimental Evaluation of Major Innovative Technologies

Project Number: EE-45

Date: September 1993

Budget Activity: 2. Advanced Technology Development

A. (U) RESOURCES: (\$ In Thousands)

Project Title: Global Grid Communications

Popular Name	FY 1993 Actual	FY 1994 Estimate	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	To Complete	Total Program
EE-45									
Global Grid Communications	0	20,881	42,843	45,926	39,842	32,592	5,435	0	187,769

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: This program develops and demonstrates advanced communications technologies needed for defense and intelligence operations for the 21st century. The program will develop advanced information processing concepts to support a geographically dispersed staff for crisis management. Services for an enhanced information infrastructure to support command and control will be developed and shown to be applicable to advanced, high performance (and commercially available) networks. This program will demonstrate that commercial communications resources and technologies can be integrated with advanced optical components developed in this program as well as DoD tactical and satellite technology developed elsewhere. The key elements are:

- (U) Applications such as intelligent decision aids, that enable a geographically distributed planning staff to develop and analyze a course of action within 4 hours.
- (U) Advanced services such as scalable file systems, databases, and distributed computing support that are integrated with high performance computing, and free applications from the necessity to work down to the raw data transport level.
- (U) Demonstration networks that validate the Research and Development (R&D) and enable early application development and technology transition into DoD efforts such as Defense Information System Networks.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #06032226E

Project Number: EE-45 Date: September 1993
PE Title: Experimental Evaluation of Budget Activity: 2. Advanced Technology Development
Major Innovative Technologies

- (U) Develop network controls pertaining to management, and security software technologies to enable sensor-to-shooter applications combining all network media.
- (U) Develop optical components that permit the DoD to substantially reduce the number of fibers, switches, and repeaters required for deployment of gigabit network capability. Electronic content will be reduced so that the cost of electronic upgrades is minimized.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program: New start in FY 1994.

(U) FY 1994 Planned Program:

- (U) Design the software architecture and conduct initial tests for joint task force planning/execution including weather, intelligence, strike planning and logistics. (\$6.3M)
- (U) Initiate network management, control, signaling efforts. (\$1.6M)
- (U) Demonstrate interoperability between commercial and DoD network assets. (\$3.8M)
- (U) Develop optical component. (\$.5M)
- (U) Perform network optimization design and modeling of multi-wavelength technology. (\$.8M)
- (U) Initiate optical component development: switch, multiplexer, filter, amplifier and synchronizer. (\$3.0M)
- (U) Initiate experiments and development of signal and control software on interconnected network. (\$4.9M)

(U) FY 1995 Planned Program:

- (U) Design and conduct initial assessments of information services for the defense internet; evaluate prototype software components in a software engineering testbed and during an operational exercise. (\$22.0M)

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603226E

Project Number: EE-45 Date: September 1993

PE Title: Experimental Evaluation of

Budget Activity: 2. Advanced Technology Development

Major Innovative Technologies

- (U) Integrate DoD and commercial networks with military attributes such as crypto surge capability. (\$1.5M)
 - (U) Demonstrate advanced optical network capability. (\$.3M)
 - (U) Initiate multi-wavelength network architecture and protocol analysis. (\$1.0M)
 - (U) Fabricate and demonstrate optical components for multi-wavelength operation. (\$4.0M)
 - (U) Fabricate and demonstrate optical components for ultra-short pulse technology. (\$3.0M)
 - (U) Demonstrate multi-wavelength reconfigurable network architecture. (\$4.0M)
 - (U) Demonstrate services and network management in support of DoD experimental application. (\$7.0M)
- (U) FY 1996 Planned Program:
- (U) Demonstrate evolving software development practices and the migration of software applications and information services to higher bandwidth networks in an operational exercise involving multiple JTFS. (\$21.9M)
 - (U) Demonstrate integration on a CONUS scale using all networks. (\$1.0M)
 - (U) Demonstrate indium phosphide optoelectronic integrated component technology. (\$5.0M)
 - (U) Demonstrate and assess multi-wavelength operation in a metropolitan area network. (\$4.0M)
 - (U) Demonstrate and assess ultra-short pulse architecture in a local area network. (\$3.0M)
 - (U) Incorporate optical component technology in advanced network service and applications. (\$4.0M)
 - (U) Demonstrate end-to-end crypto and signaling at gigabit rates. (\$7.0M)

(U) Program to Completion: This is continuing program.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603226E

Project Number: EE-45 Date: September 1993

PE Title: Experimental Evaluation of
Major Innovative Technologies

Budget Activity: 2. Advanced Technology Development

D. (U) WORK PERFORMED BY: Competitive award of contracts. Major performers will include telecommunications, electronic and computing companies.

E. (U) COMPARISON WITH FY 1994 DESCRIPTIVE SUMMARY: New start in FY 1994.

F. (U) PROGRAM DOCUMENTATION: None.

G. (U) RELATED ACTIVITIES: The program is coordinated with: The national High Performance Computing and Communication Program (that will provide theory and limited-area experience), the ARPA consortia on all-optical network and optoelectronic components, the component crypto development by NSA, and the JDL C3 and Computer Science panels. This program will produce the system technologies required by Global Surveillance and Communication thrust area activities.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. (U) MILESTONE SCHEDULE:

Planned

Apr 95
Jul 95

Sep 95

May 96

May 97

Milestones

Demonstrate optical component prototypes.

Multiple crisis scenario (integrated simulation and modeling tools, more powerful trade-off analysis).

Integrate defense high performance networks with crosscountry backbone using SONET/ATM. Early planning support demonstrations.

Demonstrate network combining crypto, commercial communications, and defense secure wireless, satellite.

Demonstrate integration with advanced optical testbeds. Large scale planning demonstrations.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603226E

PE Title: Experimental Evaluation of
Major Innovative Technologies

Project Number: EE-45

Date: September 1993

Budget Activity: 2. Advanced Technology Development

Jul 97

Deplorable JTF C3 (mobile C3, plan rehearsal and refinement during deployment, intelligent interfaces).

May 98

Cross-country demonstration of optical and advanced network management.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603569E
 PE Title: Advanced Submarine Technology

Project Number: AS-01 Date: September 1993
 Budget Activity: 2. Advanced Technology Development

A. (U) RESOURCES: (\$ In Thousands)

Project Title: Advanced Submarine Technology		FY 1993		FY 1994		FY 1995		FY 1996		FY 1997		FY 1998		FY 1999		Total	
Popular Name	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Program Complete
AS-01	SUBTECH	52,952	32,556	29,576	27,273	35,234	34,883	36,230					Continuing	Continuing			

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: The evolving worldwide threat of quiet diesel submarines and the proliferation of sophisticated submarine-launched weapons available to third world countries necessitate that the US continue to maintain a superior submarine force. US submarine technologies must keep pace with changing threats and remain immune to technological surprises. In addition, defense budget reductions mandate that increasing emphasis be put on affordability considerations in the future design and construction of all classes of ships. The main thrust of this project is to provide far-term solutions to increase ship affordability and provide enhanced capability for submarines to operate in their new environment by means of advances in structural vibration control, automation technologies, fluid/structure boundary interaction control and advanced structures and materials.

(U) This project continues to develop and demonstrate innovative technologies initiated under active structural control, hydrodynamic control, advanced materials/structures, and structural acoustics efforts to reduce ship observables. These technologies will significantly enhance submarine stealth and survivability. They also form the basis for efforts to increase the affordability of various ship classes through improvements in ultra-high precision machinery used for fabricating shipboard noise-critical applications, structural acoustic design capabilities, innovative machinery mounting systems, active structural control and high reliability propulsion systems. Advanced thick section composites and embedded sensors efforts are demonstrating the advanced structural fabrication processes and strength monitoring capabilities necessary to introduce affordable advanced lightweight structural materials into ship construction programs.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603569E
PE Title: Advanced Submarine
Technology

Project Number: AS-01 Date: September 1993
Budget Activity: 2. Advanced Technology Development

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program:

- (U) Demonstrated Advanced Vibration Reducer (AVR) on Linear Test Rig (LTR); began fabrication of full scale components; transitioned to Navy in August 1993.
- (U) Designed, fabricated, and tested two and four foot non-autoclave cure spheres and cylinders for composite demonstration article.
- (U) Designed and fabricated two foot modular end dome (MED) for composite demonstration article.
- (U) Developed specifications for active vibration control system for affordable high precision fabrication of noise-critical machinery components.
- (U) Tested active structural control (ASC) high speed, low latency control processor.
- (U) Implemented mid-frequency structural acoustics code onto Stealth Designer's Workbench (SDW); developed Dimension-Adaptive Mesh Generator for SDW.
- (U) Completed feasibility report of active turbulence control; developed specification for microelectro-mechanical (MEMS) sensor/actuator skin.
- (U) Designed and fabricated composite fiber placement cylinders and frames with embedded sensors.
- (U) Completed Damage Control Reasoning and Maneuvering Control Hierarchy components of Shipboard Integrated Automation Systems.
- (U) Designed, fabricated and non-destructive evaluation (NDE) inspected flat composite resin transfer molding (RTM) panels 1 - 6" thick with embedded flaws, using ultrasonics, X-ray and thermography.
- (U) Continued development of structural modeling techniques required to analyze innovative ship construction and noise isolation technologies.

(U) FY 1994 Planned Program:

- (U) Demonstrate active sound isolation through magnetic levitation. (\$3.5M)
- (U) Integrate vector and parallel processors for Stealth Designer's Workbench (SDW). (\$0.6M)

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603569E
 PE Title: Advanced Submarine Technology

Project Number: AS-01 Date: September 1993
 Budget Activity: 2. Advanced Technology Development

- (U) Demonstrate feasibility of affordable high precision machining operations for fabrication of noise-critical machinery components. (\$0.4M)
- (U) Investigate techniques for active suppression of vibration and noise in turbines. (\$0.6M)
- (U) Complete 50:1 scale model tests and numerical simulations for hull response to machinery cradle. (\$3.0M)
- (U) Complete truss beam damping tests, design of truss attachment and numerical simulations. (\$4.5M)
- (U) Develop active control system for special warfare craft stealth and habitability. (\$0.9M)
- (U) Fabricate and test turbulence control concepts. (\$4.5M)
- (U) Fabricate non-autoclave cure thermoplastic-stiffened composite cylinders and spheres (4' diameter); begin testing Modular End Dome (MED) (2' diameter), thermoplastic cylinder and thermoset sphere (4' diameter). (\$4.0M)
- (U) Continue fabrication of SUPRELITE components; complete SUPRELITE one-year fatigue test. (\$7.0M)
- (U) Continue design and fabrication of fiber placement composites cylinders and RTM frame stiffeners with embedded sensors. (\$2.0M)
- (U) Continue development of material properties characterization tools and Non-Destructive Evaluation (NDE) methods using ultrasonics, X-ray and thermography. (\$1.5M)

(U) FY 1995 Planned Program:

- (U) Demonstrate Advanced Vibration Reducer (AVR) techniques on special warfare craft. (\$2.5M)
- (U) Develop active mounting and vibration suppression techniques for turbines and propulsion systems. (\$2.2M)
- (U) Complete design and fabrication of 1/4 scale model for machinery cradle. (\$3.0M)
- (U) Complete truss testing and numerical simulations. (\$4.0M)

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603569E

PE Title: Advanced Submarine Technology

Project Number: AS-01

Date: September 1993

Budget Activity: 2. Advanced Technology Development

- (U) Complete fabrication, assembly, and installation of SUPRELITE on submarine and conduct at-sea testing. (\$0.4M)
- (U) Continue fabrication and begin assembly of composite Man-Rated Demonstration Article (MRDA) (i.e. dry deck shelter) subscale assembly. (\$4.3M)
- (U) Begin fabrication of full scale MRDA components. (\$3.4M)
- (U) Complete fabrication and testing of cylinder with embedded sensors, and refinement of sensor demodulation and NDE methods. (\$2.3M)
- (U) Incorporate parallel codes and system identification (ID) algorithms into Stealth Designer's Workbench (SDW). (\$2.5M)
- (U) Demonstrate active fluid/structure boundary control concepts at a large scale. (\$2.3M)
- (U) Develop large-scale active structural control system for precision machining. (\$2.7M)

(U) FY 1996 Planned Program:

- (U) Integrate truss and hull structure at 1/4 scale. (\$3.3M)
- (U) Complete fabrication, assembly, and begin testing on MRDA subscale assembly. (\$5.7M)
- (U) Complete fabrication and begin assembly of MRDA full-scale assembly. (\$4.2M)
- (U) Demonstrate high precision machining for large-scale noise-critical machinery system. (\$3.6M)
- (U) Verify high speed, automated System identification (ID) for Active Structural Control. (\$6.1M)
- (U) Complete design and demonstrate global control for Special Warfare Craft Stealth System. (\$1.1M)
- (U) Complete refinement of demodulation techniques for embedded sensors. Transition to Navy. (\$1.2M)
- (U) Demonstrate selected active fluid/structure control techniques on full-scale platform. (\$2.1M)

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603569E

PE Title: Advanced Submarine
Technology

Project Number: AS-01

Date: September 1993

Budget Activity: 2. Advanced Technology Development

(U) Program to Completion: This is a continuing program.

D. (U) WORK PERFORMED BY: AT&T Bell Laboratories, Whippany, NJ; GEC-Marconi, United Kingdom; Pennsylvania State University/Applied Research Laboratory, State College, PA; McDonnell Douglas Aircraft, St. Louis, MO; Colorado School of Mines, Golden, CO.

E. (U) COMPARISON WITH FY 1994 DESCRIPTIVE SUMMARY: This program is the continuation of the Congressionally-mandated Submarine Technology Program (STP).

1. TECHNICAL CHANGES: None.

2. SCHEDULE CHANGES: None.

F. (U) PROGRAM DOCUMENTATION: Not applicable.

G. (U) RELATED ACTIVITIES: This program has been coordinated with the Program Executive Officer, Submarines (PEO-SUB-R) to ensure there is no duplication of effort and that developed technologies are properly transitioned to the Navy.

(U) The Machinery Cradle program is co-sponsored by the Navy through an MOU signed on July 23, 1993.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603569E
PE Title: Advanced Submarine
Technology

Project Number: AS-01 Date: September 1993
Budget Activity: 2. Advanced Technology Development

J. (U) MILESTONE SCHEDULE:

<u>Plan</u>	<u>Milestones</u>
Feb 94	Complete testing of the first thick composite 4-foot diameter thermoplastic sphere.
Apr 94	Complete SUPRELITE one year qualification fatigue tests.
Apr 94	Complete testing of Active Impedance Modification (AIM) 1/4-of-full scale prototype tile.
Nov 94	Complete fabrication of full scale propulsor rotor.
Apr 95	Complete installation and at-sea test of full scale propulsor rotor.
Apr 95	Conduct initial Demonstration of Special Warfare Craft active vibration and acoustics control system.
Jan 96	Conduct demonstration of high precision machine operations for noise critical machinery.
Jun 96	Complete testing of integrated 1/4-scale Machinery Cradle structure.
Jul 96	Begin testing of fully assembled subscale Man-Rated Demonstration Article (MRDA) (dry deck shelter).

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603570E

Date: September 1993

PE Title: Defense Reinvestment

Budget Activity: 2. Advanced Technology Development

A. (U) RESOURCES: (\$ In Thousands)

Project Title: Defense Reinvestment		FY 1993		FY 1994		FY 1995		FY 1996		FY 1997		FY 1998		FY 1999		Total	
Popular		Actual	Estimate	Actual	Estimate	Actual	Estimate	Actual	Estimate	Actual	Estimate	Actual	Estimate	Actual	Estimate	Actual	Estimate
Name																	
Defense Reinvestment		561,633	*349,000	325,000	325,000	325,000	325,000	325,000	325,000	325,000	325,000	321,000	321,000	320,000	320,000	Continuing	Continuing

*Includes \$25.0 million of FY 1993 Title VIII funds that will be applied to FY 1994 Manufacturing Extension and Dual-Use Assistance Extension Programs.

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: The purpose of the Defense Reinvestment program is to stimulate development of technologies that will provide both new military capability and new commercial products, and further the integration of commercial and military production and processes. Once developed and deployed, the resulting technologies will increase both national security and the national economy. The program's objectives will be achieved through the application of defense and commercial resources to develop dual-use technologies, provide manufacturing and technology assistance to small firms, and establish education and training programs designed to enhance U.S. manufacturing skills and target displaced defense industry workers. The program consists of multiple projects generally grouped into the following categories:

- (U) Defense Dual-Use Critical Technology Partnerships
- (U) Commercial-Military Integration Partnerships
- (U) Defense Advanced Manufacturing Technology Partnerships
- (U) Manufacturing Engineering Education Grant Program
- (U) Manufacturing Extension Program
- (U) Defense Dual-Use Assistance Extension Program
- (U) Funding for the Small Business Innovation Research (SBIR) Program is included within this Program Element in FY 1994-99 to strengthen the role of small business in meeting dual-use

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603570E

Date: September 1993

PE Title: Defense Reinvestment

Budget Activity: 2. Advanced Technology Development

research and development for both military and commercial applications. Regional Technology Alliances Assistance Program

(U) Agile Manufacturing/Enterprise Integration Program

(U) Advanced Materials Synthesis and Processing Partnerships

(U) U.S.-Japan Management Training Program

(U) A formal solicitation for the FY 1993 program was issued in May 1993, and approximately 2,800 proposals were received in July. The proposals are being evaluated by inter-agency selection teams; award of contracts, grants and agreements will begin in early FY 1994. Because allocation of FY 1994-96 funds by individual program is dependent on the results of the FY 1993 competition, a definitive distribution of the requested FY 1994-96 funds by program cannot be made before the FY 1993 selection process is completed.

(U) Funding for the Small Business Innovation Research (SBIR) Program is included within this Program Element in FY 1994-99 to strengthen the role of small business in meeting dual-use research and development for both military and commercial applications.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program:

- (U) Published and distributed over 10,000 program information packages and held numerous regional meetings throughout the U.S. to brief potential participants.
- (U) Established and staffed inter-agency proposal review teams and developed comprehensive guidelines for proposal evaluation.
- (U) Issued a solicitation for proposals in May 1993 and received approximately 2,800 proposals totalling over \$8.4 billion in response.
- (U) Initiated the proposal selection process and made preliminary awards.

(U) FY 1994 Planned Program:

- (U) Complete award of FY 1993-funded projects.
- (U) Execute FY 1994 increment of ongoing FY 1993 projects.
- (U) Identify and establish new partnerships.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603570E

PE Title: Defense Reinvestment

Date: September 1993

Budget Activity: 2. Advanced Technology Development

(U) FY 1995 Planned Program:

- . (U) Execute FY 1995 increment of ongoing projects begun in FY 1993 and FY 1994.
- . (U) Identify and establish new partnerships.

(U) FY 1996 Planned Program:

- . (U) Execute FY 1996 increment of ongoing projects begun in FY 1993-95.
- . (U) Identify and establish new partnerships.

(U) Program to Completion: Continuing.

D. (U) WORK PERFORMED BY: Partnerships are composed of industry, federal laboratories, institutions of higher education, state government agencies, Government-owned and operated industrial facilities, and other entities that support the activities of the firms or non-profit research corporations.

E. (U) COMPARISON WITH FY 1994 DESCRIPTIVE SUMMARY: The FY 1995 and FY 1996 program funding will continue promising research activities initiated in prior years, as well as funding new projects. Programmed FY 1995 and FY 1996 funding will continue Defense Reinvestment program activities at a level consistent with the FY 1994 funding request.

F. (U) PROGRAM DOCUMENTATION: Not applicable.

G. (U) RELATED ACTIVITIES: Ongoing government research projects.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. (U) MILESTONE SCHEDULE: Not applicable.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603739E Date: September 1993
 PE Title: Electronics Manufacturing Technology Budget Activity: 2. Advanced Technology Development

A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1993 Actual	FY 1994 Estimate	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	To Complete	Total Program
MT-02 Microwave/Millimeter Wave Monolithic Integrated Circuits (MIMIC)	81,579	80,181	17,188	0	0	0	0	0	571,209
MT-03 IR Focal Plans Array (IRFPA)	34,150	41,429	45,100	43,200	14,400	0	0	0	195,683
MT-04 Electronic Module Technology	66,376	98,080	132,648	146,512	83,426	99,502	84,472	Continuing	Continuing
MT-05 Tactical Display Systems	10,078	9,467	15,407	21,161	19,894	17,000	15,500	Continuing	Continuing
MT-06 Microwave and Analog Front End Technology (MAFET)	0	0	36,002	49,634	63,936	79,980	84,201	Continuing	Continuing
MT-07 Centers of Excellence	27,664	4,837	0	0	0	0	0	0	32,501
MT-08 Manufacturing Technology Initiatives	0	19,146	44,433	70,655	64,472	49,691	0	0	253,396
MT-09 Dual-Use Design and Manufacturing Technology	0	0	30,564	49,742	51,751	39,235	20,000	Continuing	Continuing

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603739E Date: September 1993
 PE Title: Electronics Manufacturing Budget Activity: 2. Advanced Technology Development Technology

MT-10	*Advanced Lithography (71,162)	47,457	25,000	25,000	25,000	25,000	Continuing	Continuing
Total		<u>219,847</u>	<u>300,597</u>	<u>346,342</u>	<u>405,904</u>	<u>322,879</u>	<u>310,408</u>	<u>229,173</u>

*Previously funded in PE 0602712E, Project MPT-04.

B. (U) BRIEF DESCRIPTION OF ELEMENT: The Electronics Manufacturing Technology program element seeks to design and demonstrate state-of-the-art manufacturing and process technologies for the production of various electronics and microelectronic devices, sensor systems, actuators, gear drives that have both commercial and military applications. Introduction of advanced product design capability and flexible, scalable manufacturing techniques will enable the commercial sector to rapidly and cost-effectively satisfy military requirements and enhance the U.S. industrial base.

(U) The objective of the Microwave/Millimeter Wave Monolithic Integrated Circuits (MIMIC) project is to accelerate the development, manufacturing and demonstration of affordable microwave and millimeter wave analog integrated circuits. This technology will be the basis for the efforts in the Microwave and Analog Front End Technology (MAFET) program (MT-06) beginning in FY 1995. The MAFET program will further enhance microwave and millimeter wave module performance at reduced costs.

(U) The IR Focal Plane Array project focuses on the establishment of a manufacturing base for advanced infrared sensor arrays for major weapons systems. This base will allow the systems to meet operating requirements at approximately 1% of the current cost.

(U) The goal of the Electronic Module Technology project is to allow for the timely insertion and rapid acquisition of state-of-the-art microprocessors and actuators, conformal electronics and affordable, high performance application specific electronic module (ASEM), components into

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603739E

PE Title: Electronics Manufacturing Technology

Date: September 1993

Budget Activity: 2. Advanced Technology Development

major military systems. These systems include automatic target recognition, electronic counter-measures and Signal Intelligence (SIGINT). This project includes Advanced Technology Demonstrations (ATDS) in ASEM and Rapid Prototyping of Application Specific Signal Processor (RASSP).

(U) Tactical Display Systems projects develop and demonstrate high definition miniature displays to provide visual information to individual combatants and small groups who are remotely located from conventional visual information sources.

(U) The Centers of Excellence program finances demonstration, deployment of and training on advanced manufacturing technologies. The goal of this technology is to reduce unit and life cycle costs while improving quality.

(U) The goal of the Manufacturing Technology Initiatives program is to reduce the cost and acquisition leadtime of future military systems by integrating manufacturing process considerations during the product design phase, and by demonstrating high efficiency multi-product prototype factories. The project funds two Advanced Technology Demonstrations, the Active Electronically Scanned Arrays (AESAs) project and the Flexible Design and Assembly of Missile and Munitions Seekers (FDMMS) project, to provide practical examples of these concepts.

(U) The Dual-Use Design and Manufacturing project will enable manufacturers to economically produce military variants of their commercial products in limited quantities through the introduction of flexible process technologies. Key concepts that are integral to dual-use manufacturing capability such as advanced design systems scalable components and subsystems, flexible factory systems, and improved manufacturing operations control will be demonstrated in two ATDS: the Interferometric Fiber Optics Gyroscopes (IFOG) and Dual-Use Manufacturing of Electric Drive System (DUEDS) projects.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603739E
 PE Title: Electronics Manufacturing Technology
 Project Number: MT-02
 Budget Activity: 2. Advanced Technology Development
 Date: September 1993

A. (U) RESOURCES: (\$ In Thousands)

Project Title: Popular Name	FY 1993		FY 1994		FY 1995		FY 1996		FY 1997		FY 1998		FY 1999		Total	
	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Complete	Program
MT-02	81,579	80,181	17,188	0	0	0	0	0	0	0	0	0	0	0	0	571,209

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: This project provides for the acceleration of development, manufacturing and demonstration of affordable microwave and millimeter wave analog integrated circuits (ICs). The Microwave/ Millimeter Wave Monolithic Integrated Circuits (MIMIC) program is providing previously unavailable microwave and millimeter-wave integrated circuits to enable DoD systems to meet size, weight and power constraints at the lowest possible cost. Its primary thrust is to develop affordable circuits operating in the 1 to 100 GHz frequency range with required characteristics and in sufficient quantity to satisfy military systems needs. The use of reliable and maintainable semiconductor devices and circuits for selected system demonstrations will be accelerated and, thus provide the United States with a technological lead in deploying MIMIC-based military systems.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

- (U) FY 1993 Program:
- (U) Delivered first multi-function MIMICs meeting required system specifications.
 - (U) Began assembly of advanced MIMIC modules and system brassboards.
 - (U) Continued development of advanced materials, devices, design software, packaging and testing technologies.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603739E

PE Title: Electronics Manufacturing Technology

Project Number: MT-02

Date: September 1993

Budget Activity: 2. Advanced Technology Development

(U) FY 1994 Planned Program:

- (U) Continue work on MIMIC Phase 2 contracts including delivery of process demonstration wafers, completion of MIMIC Phase 2 chip fabrication and continue assembly of MIMIC modules and brassboards.

(U) FY 1995 Planned Program:

- (U) Completion of program including delivery of MIMIC chips, modules and brassboards and demonstrations of advanced technology and hardware.

D. (U) WORK PERFORMED BY: In-house work will be performed by: Army Research Laboratory; Naval Air Systems Command; U.S. Naval Research Laboratory; Air Force Wright Laboratory, and Rome Laboratory. Hardware development phase prime contractors are: Hughes Aircraft Company, El Segundo, CA; General Electric, Syracuse, NY; Martin-Marietta, Orlando, FL; ITT, Roanoke, VA; Raytheon Co., Bedford, MA; Texas Instruments, Dallas, TX; and TRW, Redondo Beach, CA.

E. (U) COMPARISON WITH FY 1994 DESCRIPTIVE SUMMARY: The change in total program cost reflects the results of a phased completion of the MIMIC program.

F. (U) PROGRAM DOCUMENTATION:

- (U) Management structure for the Microwave/Millimeter Wave Monolithic Integrated Circuits (MIMIC) Program, 9/85.
- (U) Program Plan for MIMIC, 5/86.
- (U) Acquisition Plan No. DoD 86-X for MIMIC Program, 10/86.

G. (U) RELATED ACTIVITIES: Exploratory and advanced development of gallium arsenide monolithic components are being undertaken within the following Army, Navy, Air Force RDT&E program elements:

- (U) Program Element #0602705A, Electronics and Electronic Devices
- (U) Program Element #0602234N, Systems Support Technology

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603739E Project Number: MT-02 Date: September 1993
PE Title: Electronics Manufacturing Budget Activity: 2. Advanced Technology Development
Technology

- (U) Program Element #0602204F, Aerospace Avionics

(U) The work performed within this project is complementary to the work performed in the Service program elements. MIMIC is a ARPA funded and managed/Tri-Service coordinated program. Each of the Military Departments has set up a MIMIC Program Office to provide management and support for the MIMIC Program's contractual efforts.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. (U) MILESTONE SCHEDULE:

Plan	Milestones
Jun 94	Complete fabrication of MIMIC chips.
Jan 95	Deliver MIMIC Phase 2 chips, modules and brassboards.
Jan 95	Complete integrated design/fabrication/test capabilities at MIMIC Phase 2 contractors.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603739E Project Number: MT-03 Date: September 1993
 PE Title: Electronics Manufacturing Budget Activity: 2. Advanced Technology Development
 Technology

A. (U) RESOURCES: (\$ In Thousands)

Project Title: IR Focal Plane Array		FY 1993		FY 1994		FY 1995		FY 1996		FY 1997		FY 1998		FY 1999		Total	
Popular	Name	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Complete	Program
MT-03	IRFPA	34,150	41,429	45,100	43,200	14,400	0	0	0	0	0	0	0	0	0	0	195,683

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: The Infrared Focal Plane Array (IRFPA) project establishes a manufacturing base for advanced infrared (IR) sensor arrays required for major weapon systems. Improvements in infrared materials, detector array fabrication, read-out electronics, cryogenic testing and module assembly are addressed in order to provide affordable infrared sensors to system developers. Systems requiring affordable tactical infrared focal plane arrays include missile seekers, airborne and ground-based target acquisition systems, and infrared search and track systems. Currently, the IRFPAs are produced at low rates and high cost with technology that is just emerging from the laboratory environment. The goal of this project is to produce IRFPAs that meet system requirements with a hundred-fold cost reduction relative to the cost at the beginning of the project. The project reflects the OSD Advanced Technology Demonstration for scalable IRFPA manufacturing.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program:

- (U) Demonstrated vapor phase growth of cadmium zinc telluride on silicon substrates to produce large-area long-wavelength staring arrays.
- (U) Demonstrated improved screening of IR material; x2 increase in the arrays passing wafer-level evaluation.
- (U) Manufactured large, 480x4, scanning IRFPAs with improved reliability (greater than 1,000 thermal cycles without failure).

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603739E
PE Title: Electronics Manufacturing Technology
Project Number: MT-03 Date: September 1993
Budget Activity: 2. Advanced Technology Development

- (U) Implemented manufacturing technology using a two-inch substrate, which contains more than 60 64x64 IRFPAs.
- (U) Implemented improved control over infrared material growth process as initial demonstration of flexibility in IRFPA manufacturing.
- (U) Initiated activity for a physical model describing defects in IR material as the initial step toward flexible IRFPA manufacturing.

(U) FY 1994 Planned Program:

- (U) Demonstrate improved wafer morphology to reduce defect density in long-wavelength staring arrays.
- (U) Complete physical model describing IR detector surface leakage mechanism.
- (U) Fabricate modules for tactical applications.
- (U) Complete read-out circuit design and fabricate read-out common to mid- and long-wavelength devices.
- (U) Demonstrate long wavelength scanning arrays with cut-off wavelength of 11.0 microns at 68K.
- (U) Laboratory demonstration of flexible IRFPA manufacturing processes.

(U) FY 1995 Planned Program:

- (U) Demonstration of one-hundred times (X100) cost reduction for 480x4 infrared focal plane arrays useful for ground and airborne applications.
- (U) On-line demonstration of electrical functionality probing of detector arrays on wafers.
- (U) Demonstration of 128x128 infrared focal plane array with improved spatial uniformity for missile seeker applications.
- (U) Integration of completely dry processing into the infrared detector fabrication line.
- (U) Laboratory demonstration of cluster tool concept for flexible manufacturing.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603739E

Project Number: MT-03

Date: September 1993

PE Title: Electronics Manufacturing Technology

Budget Activity: 2. Advanced Technology Development

(U) FY 1996 Planned Program:

- (U) Demonstration of in-situ critical parameter sensing for processing infrared arrays of varying spectral response.
- (U) Demonstration of reduction in processing cycle-time for arrays with both three-to-five and eight-to-ten micron spectral response.
- (U) Fabrication of large area (256 by 256) staring array with operation at 200K.
- (U) Integration of manufacturing tools for flexible fabrication of arrays of various geometries and pixel sizes.

(U) Program to Completion:

- (U) Demonstrate large-area 480x640 mercury cadmium telluride IRFPAs on a silicon substrate.
- (U) Demonstrate manufacturing technology for 64x64 staring arrays with greater than 95% operability at a cost of less than \$2,000 per IRFPA.
- (U) Demonstrate 128x128 IRFPAs on a silicon substrate for greater ease of material handling and compatibility with commercial manufacturing equipment.
- (U) Demonstrate IRFPA manufacturing with 4-inch wafers.
- (U) Complete the development of an integrated manufacturing capability for large-area (4-inch diameter) infrared sensitive semiconductor wafers demonstrating a 100 times cost reduction for both staring and scanning arrays.
- (U) Demonstrate flexible, modular IRFPA manufacturing with the capability to rapidly reconfigure the line to produce 3-5 and 8-12 micron arrays for tactical and space surveillance applications.

D. (U) WORK PERFORMED BY: Contractors include: Santa Barbara Research Center, Santa Barbara, CA; Loral Infrared and Imaging Systems, Lexington, MA; Rockwell, Anaheim, CA; Texas Instruments, Dallas, TX; Hughes Research Lab, Malibu, CA; and Martin Marietta, Orlando, FL and Schenectady, NY.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603739E

PE Title: Electronics Manufacturing Technology

Project Number: MT-03

Date: September 1993
Budget Activity: 2. Advanced Technology Development

E. (U) COMPARISON WITH FY 1994 DESCRIPTIVE SUMMARY: Consistent with the FY 1994 Descriptive Summary.

F. (U) PROGRAM DOCUMENTATION: Not applicable.

G. (U) RELATED ACTIVITIES: Development of Infrared Focal Plane Array (IRFPA) technology and devices is being undertaken under Army, Navy, Air Force and Advanced Research Projects Agency (ARPA) program elements. The related Service program elements are:

- (U) PE 0602709A, Night Vision Technology.
- (U) PE 0603774A, Night Vision System Advanced Development.
- (U) PE 0602234N, Systems Support Technology.
- (U) PE 0602204F, Aerospace Avionics.

(U) The project supports development of flexible IRFPA manufacturing, capable of meeting tri-Service requirements. All Service and ARPA efforts are closely coordinated to assure that there is no duplication of effort.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. (U) MILESTONE SCHEDULE:

	Plan	Milestones
Sep 93		Demonstrated feasibility of a process module for infrared focal plane array manufacturing.
Aug 94		Demonstrate a 100 times cost reduction in the manufacture of two-dimensional, staring IRFPAs.
Sep 95		Assemble scalable focal plane array facility.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603739E

PE Title: Electronics Manufacturing Technology

Project Number: MT-03

Date: September 1993

Budget Activity: 2. Advanced Technology Development

Jan 96

Jun 96

Sep 96

Sep 97

Dec 97

Demonstrate process module concept for multi-purpose scanning arrays.

Demonstrate equipment with flexibility to produce various IRFPA configurations on the same line.

Demonstrate large-area staring and scanning array for search and track, target acquisition, and missile seeker systems.

Demonstrate high-yield IRFPA manufacturing facility capable of varying production rates from small lots to high throughput rates.

Completion of modular infrared focal plane array manufacturing capability, scalable from low volume (single wafer processing) to higher production volume (ten wafer lots @ over 10,000 wafers per year); with single wafer cycle time of ten days.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603739E

Project Number: MT-04

Date: September 1993

PE Title: Electronic Manufacturing Technology

Budget Activity: 2. Advanced Technology Development

A. (U) RESOURCES: (\$ In Thousands)

Project Title: Electronic Module Technology

Popular Name	FY 1993 Actual	FY 1994 Estimate	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	To Complete	Total Program
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MT-04	Electronic Module Technology	66,376	98,080	132,648	146,512	83,426	99,502	84,472	Continuing
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B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: The Electronic Module Technology Project is a broad initiative to substantially decrease the cost while increasing the performance of weapon systems through the timely insertion of state-of-the-art electronic modules. Electronic module technology addresses the interconnection and physical packaging of various types of digital and analog integrated circuits, as well as other electronic, electro-optical and micro-mechanical components. It includes traditional approaches such as printed circuit boards, emerging technologies such as high density multichip modules (MCMs), and revolutionary approaches such as "conformal electronics".

(U) The project has four major objectives: (1) shorten the overall design, manufacture, test, and insertion cycle for advanced electronic subsystems; (2) advance the state-of-the-art in electronic interconnection and physical packaging technology to allow circuits to operate close to their intrinsic maximum speed with less overhead in terms of volume, weight and cost; (3) provide a robust manufacturing infrastructure for electronic modules; and (4) demonstrate the system level payoff of electronic module technology through advanced technology demonstrators (ATDs).

(U) The project has the following major elements: (1) High-Density Physical Packaging; (2) Application Specific Electronic Modules (ASEM); (3) Multichip Integration (MCI); (4) Rapid Prototyping of Application Specific Signal Processors (RASSP); and (5) Microelectromechanical Systems (MEMS). High-density physical packaging will develop and exploit high-density packaging

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603739E

Project Number: MT-04

Date: September 1993

PE Title: Electronic Manufacturing Technology

Budget Activity: 2. Advanced Technology Development

technology for digital and mixed analog/digital electronics with clock rates up to several GHz and manufacturing processes that will lead to the production of complex shape, lightweight, and high density microwave frequency multichip modules and sub arrays. ASEM will reduce the non-recurring engineering time and cost for designing and inserting complex electronic modules. MCI will produce order of magnitude reductions in manufacturing cost and to accelerate the acceptance and insertion of multichip integration technologies. RASSP is a major new ARPA/Tri-Service initiative which seeks to dramatically reduce the development time and life cycle cost of advanced signal processing capability while ensuring state of the art performance when the processor is fielded, not just when it is first defined. MEMS supports information technology for mobile systems and active individuals: microdynamics devices and systems, wireless/low-power communication and conformal/embedded manufacturing.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program:

- (U) Established merchant multichip module (MCM) prototype production and initiated High-Density Microwave Packaging Program.
- (U) Continued the ASEM Program with the establishment of three merchant foundries and the initiation of CAD tool development.
- (U) Initiated the MCI program with the establishment of a Flip-Chip Center and funding of innovative manufacturing equipment and multichip module insertions.
- (U) Awarded RASSP primary development contracts along with technical base and benchmark efforts.
- (U) Integrated MEMS multiple device simulators into a common description language and selected defense-relevant microdynamic array applications.

(U) FY 1994 Planned Program:

- (U) Continue development and demonstration of 10-100X packaging density improvement for digital processors, memories, and analog circuits operating at clock rates up to 500 MHz. (\$5.9M)

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603739E

PE Title: Electronic Manufacturing Technology

Project Number: MT-04

Date: September 1993

Budget Activity: 2. Advanced Technology Development

- (U) Continue the ASEM program with addition support for the flexible-access foundry system focusing on the board level integration of MCMs. (\$25.4M)
 - (U) Continue the MCI program with the establishment of large format equipment development programs and the initiation of selected MCM insertions. (\$28.2M)
 - (U) Expand RASSP technical base development and demonstrate first versions of design environment, circuits and virtual prototypes. (\$38.6M)
- (U) FY 1995 Planned Program:
- (U) Continue development of microwave frequency multichip module housings, internal packaging interconnections, array interconnect technology, module assembly and integration and CAD tools and databases. (\$6.7M)
 - (U) Continue the ASEM program with heightened emphasis on mixed signal modules and application demonstrations. (\$29.5M)
 - (U) Continue the MCI program with further development of manufacturing equipment and focusing on the delivery of production modules for military aircraft and other dual-use applications. (\$25.0M)
 - (U) Deliver preliminary RASSP benchmark evaluations and demonstrate improved CAD technology, VHDL extensions, advanced algorithms, and improved design environment. Complete first RASSP system demonstration hardware. (\$46.8M)
 - (U) Develop high-yield, high-uniformity, high aspect-ratio fabrication processes for Microelectromechanical Components and Systems and merge with related fabrication technologies in optics, optoelectronics and microwave devices. (\$25.0M)
- (U) FY 1996 Planned Program:
- (U) Continue module component and CAD tool development; begin module integration and testing; and begin assembly of brassboard array. (\$9.4M)
 - (U) Continue the ASEM program concentrating on the demonstration of the ASEM goals of lowering the barriers to entry of the MCM market by reducing the cycle time and cost of production. (\$31.0M)

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603739E

PE Title: Electronic Manufacturing Technology

Project Number: MT-04

Date: September 1993

Budget Activity: 2. Advanced Technology Development

- (U) Continue the MCI program concentrating on the delivery low cost laminate technology and the development of optimized modules and mixed signal applications. (\$25.0M)
- (U) Deliver RASSP benchmark evaluations and accelerated framework standards and improved CAD technology. Demonstrate complete end-to-end design framework and additional demonstration hardware. (\$46.1M)
- (U) Demonstrate hybrid microdynamic, optical optoelectronic and microwave devices and systems. Integrate computation, control and communication with MEMS-based microsensors, actuators and mechanical structures in embedded manufacturing processes. (\$35.0M)

(U) Program To Completion: This is a continuing program.

D. (U) WORK PERFORMED BY: Major contractors include: Texas Instruments, Dallas, TX; N-chip, San Jose, CA; Motorola Corp., Chandler, AZ; IBM Corp., Manassas, VA and East Fishkill, NY; Martin-Marietta Corp, Moorestown, NJ; Lockheed Sanders Inc., Nashua, NH; and E-Systems Inc., Greenville, TX. Additional contractors will be determined by competitive selection. In-house work, including management and support of contractual efforts will be performed by: Department of the Army, U.S. Army Laboratory Command, Ft Monmouth, NJ; Naval Air Systems Command; and the Air Force, Wright Laboratories.

E. (U) COMPARISON WITH FY 1994 DESCRIPTIVE SUMMARY: Increased funding in FY 1995 and 1996 incorporating microelectromechanical systems (MEMS) and Multi-Chip Integration demonstrations.

F. (U) PROGRAM DOCUMENTATION: Not applicable.

G. (U) RELATED ACTIVITIES: This effort will be closely coordinated with Program Element 0602301E, ST-19, High Performance Computing and Communications (HPCC) and Program Element 0603739E, MT-05, Tactical Display Systems (TDS) programs which will provide applications for demonstrating the new technologies.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603739E

PE Title: Electronic Manufacturing Technology

Project Number: MT-04

Budget Activity: 2. Advanced Technology Development

Date: September 1993

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. (U) MILESTONE SCHEDULE:

Plan

Nov 93	Integrate first version of RASSP design environment.
Feb 94	Fabricate and test first RASSP signal processing circuits.
Jun 94	Deliver first ASEM Modules for dual use application.
Jun 94	MCI Manufacturing Technology Demonstrations.
Jun 94	First virtual prototype of RASSP System demonstration design.
Feb 95	Demonstrate ASEM \$50,000 non-recurring engineering cost 60 day cycle time for 10 chip Multichip Modules.
Mar 95	Demonstrate MCM insertions in OH-58D Image Processor.
Mar 95	Establish quick-turnaround SEM-E board foundry.
Sept 95	Complete high density microwave packaging (HDMP) initial development of housings, inter-chip and inter-layer interconnections and testing.
Sept 95	Complete HDMP developments of initial versions of specialized microwave packaging CAD tools and databases.
Mar 96	Demonstrate improved versions of RASSP design environment.
Jun 96	Complete HDMP final development of housings, interconnect approaches and perform initial module testing.
Aug 96	Begin assembly of HDMP brassboard array and perform initial testing.
Sept 96	Deliver MCI Manufacturing Technology to the dual-use market.

Milestones

Integrate first version of RASSP design environment.
 Fabricate and test first RASSP signal processing circuits.
 Deliver first ASEM Modules for dual use application.
 MCI Manufacturing Technology Demonstrations.
 First virtual prototype of RASSP System demonstration design.
 Demonstrate ASEM \$50,000 non-recurring engineering cost 60 day cycle time for 10 chip Multichip Modules.
 Demonstrate MCM insertions in OH-58D Image Processor.
 Establish quick-turnaround SEM-E board foundry.
 Complete high density microwave packaging (HDMP) initial development of housings, inter-chip and inter-layer interconnections and testing.
 Complete HDMP developments of initial versions of specialized microwave packaging CAD tools and databases.
 Demonstrate improved versions of RASSP design environment.
 Complete HDMP final development of housings, interconnect approaches and perform initial module testing.
 Begin assembly of HDMP brassboard array and perform initial testing.
 Deliver MCI Manufacturing Technology to the dual-use market.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603739E Project Number: MT-05 Date: September 1993
 PE Title: Electronics Manufacturing Technology Budget Activity: 2.. Advanced Technology Development

A. (U) RESOURCES: (\$ In Thousands)

Project Title: Tactical Display Systems (TDS)		FY 1994		FY 1995		FY 1996		FY 1997		FY 1998		FY 1999		To		Total	
Name	Actual	Estimate		Estimate		Estimate		Estimate		Estimate		Estimate		Complete		Program	
MT-05		Tactical Display Systems (TDS)														Continuing Continuing	
	10,078	9,467		15,407		21,161		19,894		17,000		15,500					

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENTS AND SYSTEM CAPABILITIES: This project is a major DoD effort to develop the technology for displays and portable information systems for use in a variety of military systems. This technology is important for virtually all DoD applications which involve visual and graphic information. Major applications of this technology include small combat durable displays for head mounted, hand held, or otherwise portable systems that will be used in aircraft and helicopter cockpits, armored vehicles, submarines, AEGIS cruisers, aircraft carrier flight decks, military simulators, command centers and individual infantrymen. This technology will provide greater resolution for the smaller intelligence and reconnaissance platforms required for potential future conflicts and greater combat durability for these display systems based upon modular design concepts. A major objective of this program is to develop small displays and to integrate these into ongoing and future military portable information systems to significantly improve mission effectiveness for individual combatants and small groups.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program:

- (U) Head Mounted Displays - This effort will develop small format, lightweight, high-resolution head mounted display systems. Emphasis in this fiscal year is on the development of the small displays, design of a "goggle" mounting configuration and supporting technologies.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603739E

PE Title: Electronics Manufacturing Technology

Project Number: MT-05 Date: September 1993

Budget Activity: 2. Advanced Technology Development

(U) FY 1994 Planned Program:

- (U) Head Mounted Displays - Emphasis in this fiscal year will be on the completion of the small format displays, head mounted apparatus, and system interfaces for a Combat Vehicle Crew Head Mounted Display. (\$9.5M)

(U) FY 1995 Planned Program:

- (U) Head Mounted Displays - Emphasis will be on demonstrating a Combat Vehicle Crew Head Mounted Display System and initiating a super high-resolution, small format display development. (\$9.4M)
- (U) Tactical Information Assistants - This effort will develop light, thin, portable information systems for active, mobile users that focus on rapid prototyping with end-users in the design loop. Emphasis will be on modifying a field qualified, hand-held laser rangefinder to provide improved surveillance information gathering and transmission. (\$6.0M)

(U) FY 1996 Planned Program:

- (U) Head Mounted Displays - This effort will continue developing small format, lightweight, high-resolution head mounted display systems. Emphasis will be on development of super high-resolution, small format displays. (\$9.2M)
- (U) Tactical Information Assistants - This effort will develop light, thin, portable information systems for active, mobile users that focus on rapid prototyping with end-users in the design loop. Emphasis will be on demonstrating a modified hand-held laser rangefinder to provide improved surveillance information gathering and transmission. (\$12.0M)

(U) Program to Completion: This is a continuing program.

D. (U) WORK PERFORMED BY: The major performers are: Kopin Corporation, Taunton, MA; Planar Systems, Beaverton, OR; David Sarnoff Research Laboratory, Princeton, NJ; Honeywell Systems and Research Center, Bloomington, MN; Motorola, Inc., Phoenix, AZ; and MIT, Boston, MA.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603739E

Project Number: MT-05 Date: September 1993

PE Title: Electronics Manufacturing
Technology

Budget Activity: 2. Advanced Technology
Development

(U) Service support is provided by U.S. Army Natick RDT&E Center, Natick, MA and a Joint Service Head Mounted Display Working Group consisting of members from Army, Navy, Air Force, and NASA.

E. (U) COMPARISON WITH FY 1994 DESCRIPTIVE SUMMARY: Increased funding in FY 1995 and FY 1996 for initiation of Tactical Information Assistant program.

F. (U) PROGRAM DOCUMENTATION: None.

G. (U) RELATED ACTIVITIES: This project is coordinated with the Army, Navy, Air Force and NASA through the Joint Service Head Mounted Display Working Group. There is no joint funding nor any duplication of effort involved with Service efforts in this technology.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. (U) MILESTONE SCHEDULE:

Plan	Milestones
Sep 94	(U) Complete development of 1280x1024 pixel 1-inch displays
Dec 94	(U) Complete development of head mounted mechanical configuration with optics and initiate modification of hand-held laser rangefinder
Nov 94	(U) Initiate super high-resolution display development
Dec 94	(U) Demonstrate CVC HMD
Jun 95	(U) Demonstrate "eyeglass-like" displays
Nov 96	(U) Demonstrate modification of hand-held laser rangefinder

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603739E
 PE Title: Electronics Manufacturing Technology
 Project Number: MT-06 New Start Date: September 1993
 Budget Activity: 2. Advanced Technology Development

A. (U) RESOURCES: (\$ In Thousands)

Project Title: Microwave and Analog Front End Technology	FY 1993	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	To	Total
Popular Name	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Complete	Program
MT-06	MAFET	0	36,002	49,634	63,936	79,980	84,201	Continuing	Continuing

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: This program will build upon the established technology base provided by the Microwave/Millimeter Wave Monolithic Integrated Circuits (MIMIC) program. Although a solid microwave and millimeter wave infrastructure exists because of developments achieved under the MIMIC program, work must continue to further reduce component costs while simultaneously meeting more demanding (e.g., higher power, higher efficiency, higher frequency) system performance requirements. This will enable cost effective deployment of critical DoD systems such as missiles with greater accuracy, improved all-weather communication systems, future generation radar systems, and millimeter wave frequency cameras that are able to provide rapid identification of targets under adverse environmental conditions such as smoke and fog that make infrared cameras ineffective. The program will also lead to cost-effective integrated assemblies of sensors that are essential for low cost, highly portable, highly effective military information systems.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program: Not applicable.

(U) FY 1994 Planned Program: Not applicable.

(U) FY 1995 Planned Program:

- . (U) Begin MAFET primary development phase oriented toward higher performance

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603739E

Project Number: MT-06 New Start Date: September 1993

PE Title: Electronics Manufacturing Technology

Budget Activity: 2. Advanced Technology Development

millimeter wave frequency integrated circuits using advanced materials such as indium phosphide (InP), enhancement of flexible circuit manufacturing capabilities and development of integrated microwave/digital/photonics circuitry. (\$21.0M)

- (U) Initiate MAFET technical supporting activities such as needed extensions of the Microwave Hardware Description Language (MHDL), modeling of advanced subsystems and needed test equipment and methodology. (\$9.0M)
 - (U) Initiate development of design tools and low cost manufacturing approaches for interconnection of digital, analog, and optical functions within integrated modules. (\$6.0M)
- (U) FY 1996 Planned Program:
- (U) Continue work on MAFET primary development programs including first demonstrations of InP material enhancements, and fabrication and testing of higher performance, lower cost millimeter wave integrated circuits. (\$28.0M)
 - (U) Continue work on technical supporting activities such as needed extensions of MHDL, demonstrations of advanced circuit models and implementation of advanced testing methodology. (\$9.6M)
 - (U) Continue work on CAD tools and low cost manufacturing approaches for digital/photonics, analog/photonics, and microwave/photonics interconnects. (\$12.0M)

(U) Program To Completion: This is a continuing program.

D. (U) WORK PERFORMED BY: All contracts will be competitively selected. In-house work, including management and support of contractual efforts will be performed by: Advanced Research Projects Agency (ARPA); Department of the Army, U.S. Army Research Laboratory; Department of the Navy, Naval Air Systems Command and Naval Research Laboratory; and Department of the Air Force, Wright Laboratories and Rome Laboratories.

E. (U) COMPARISON WITH FY 1994 DESCRIPTIVE SUMMARY: Not applicable.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603739E

Project Number: MT-06 New Start Date: September 1993

PE Title: Electronics Manufacturing Technology

Budget Activity: 2. Advanced Technology Development

F. (U) PROGRAM DOCUMENTATION: None.

G. (U) RELATED ACTIVITIES: This project provides technology and components that may be used in conjunction with those developed under the following other programs within this PE (Project MT-04) for improvement of DoD systems; Microelectromechanical Systems (MEMS), AESA and RASSP.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. (U) MILESTONE SCHEDULE:

Plan	Milestones
Nov 94	Initiate RFP for MAFET primary development phase contracts.
Feb 95	Initiate BAA for MAFET support activities.
May 95	Award Contracts for MAFET primary development phase.
Jun 95	Initiate contracts for MAFET primary development phase.
Jul 95	Award Contracts for MAFET supporting activities.
Dec 96	Demonstrate first InP material enhancements.
Jun 96	Demonstrate MHDL language extensions.
Jun 96	Develop manufacturing approaches for mixed signal multichip modules.
Sept 96	Demonstrate advanced millimeter wave IC chips
Mar 97	Demonstrate efficient, low cost, manufacturing approaches for digital/photonics, analog/photonics, and microwave/photonics interconnects.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603739E

Project Number: MT-08 Date: September 1993

PE Title: Electronics Manufacturing Technology

Budget Activity: 2. Advanced Technology Development

A. (U) RESOURCES: (\$ In Thousands)

Project Title: Manufacturing Technology Initiative

Popular Name	FY 1993 Actual	FY 1994 Estimate	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	To Complete	Total Program
MT-08 Manufacturing Technology Initiative	0	19,146	44,433	70,655	64,472	49,691	0	0	253,396

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENTS AND SYSTEM CAPABILITIES: Future military systems, such as sensors and missile seekers, will be affordable only if the manufacturing process is considered as an integral part of product design and if production takes place in flexible, multi-product factories. The program focus is on process technology demonstrations, providing prototype flexible factories with integrated design and manufacturing systems as well as prototype products. Included are the initiation of two Advanced Technology Demonstrations (ATDs) and additional technology base demonstrations of a prototype networked manufacturing systems infrastructure. The networked infrastructure will link computer aided design, engineering, and analysis with manufacturing systems, and will more effectively integrate dissimilar design and manufacturing systems for both military and commercial use.

(U) The two ATDs are Active Electronically Scanned Arrays (AESA) and Flexible Design and Assembly of Missile and Munition Seekers (FDAMMS). AESA will provide the advanced design and manufacturing capabilities needed to implement enhanced high-rate transmit-receive (T/R) module production and address the assembly of T/R modules into affordable arrays for radar (military and civilian), electronic warfare and missile applications. FDAMMS will develop and integrate design and flexible manufacturing systems including automated design-for-assembly tools, factory planning and control systems, advanced factory simulations, flexible high precision assembly and checkout systems to demonstrate the capability to reduce the cost of complex electro-mechanical products with missile and munition seeker assemblies as initial targets. These programs will establish benchmarks for cost and schedule reduction. Vendor involvement will result in design

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603739E

PE Title: Electronics Manufacturing Technology

Project Number: MT-08

Date: September 1993

Budget Activity: 2. Advanced Technology Development

and manufacturing systems which can be applied to numerous analogous military and commercial applications.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program: FY 1994 new start.

(U) FY 1994 Planned Program:

- (U) Begin AESA primary development phase contracts focused upon implementation of adaptable CAD tools and manufacturing of advanced design transmit/receive (T/R) modules and sub-arrays. (\$6.6M)
- (U) Conduct baseline and technology insertion assessment studies to determine key leverage points to lower total costs and cycle times for High Performance Electro-Mechanical (HPEM) devices such as missile munition seekers. Assessments will include both low and high cost devices and dual-use options as means to identify options for inserting technologies. Develop quantitative basis and metrics for ATD goals. (\$4.9M)
- (U) Begin FDAMMS development and follow-on demonstration of tools, methods and manufacturing system prototypes. (\$3.8M)
- (U) Initiate program aimed at lowering the cost of polymer matrix composites via improved manufacturing processes. (\$3.8M)

(U) FY 1995 Planned Program:

- (U) Begin AESA supporting phase contracts oriented toward development of additional specialized CAD tools, models, and appropriate testing approaches for advanced design T/R modules and sub-arrays. (\$5.8M)

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603739E

PE Title: Electronics Manufacturing Technology

Project Number: MT-08

Date: September 1993

Budget Activity: 2. Advanced Technology Development

- (U) Continue work on AESA primary development programs including initial demonstrations of integrated product/process development approach for T/R models and sub-arrays. (\$14.0M)
- (U) Expand and demonstrate advanced cost analysis and risk assessment tools and methods for design and production support for electronics, seekers, and HPEM assemblies, and begin integration of joint design activities of component developers and seeker system level designers. (\$8.2M)
- (U) Demonstrate integrated product/process design for an infrared seeker gimbal inner package (sensors, optics, dewar, and on-board electronics) including a joint demo of a concept design activity integrated with an infrared sensor contractor. (\$10.2M)
- (U) Initiate demonstration for the design and manufacture of a low-cost device including an initial demonstration of factory planning and control for multi-use factory. (\$6.2M)

(U) FY 1996 Planned Program:

- (U) Continue work on AESA primary development programs including hardware demonstrations of advanced T/R models and sub-arrays and interim demonstration of adaptable manufacturing capabilities. (\$24.9M)
- (U) Continue work on specialized CAD tools and model development including assessment of model accuracy and alpha testing of CAD tools developed. (\$8.0M)
- (U) Demonstrate an integrated design system for a complete seeker focused on feature-based design for manufacture and assembly. (\$5.3M)
- (U) Demonstrate an integrated flexible design and manufacture system for a low-cost device, including factory simulation models integrated with the seeker design system to begin support for product-process tradeoffs. (\$15.8M)
- (U) Demonstrate factory level planning, simulation and control capability for flexible, multi-product fabrication and assembly operations. (\$16.7M)

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603739E

PE Title: Electronics Manufacturing Technology

Project Number: MT-08

Date: September 1993

Budget Activity: 2. Advanced Technology Development

(U) Program to Completion:

- (U) Complete demonstration of design and manufacturing of AESAs in multiple array configurations.
- (U) Complete demonstration of design and manufacturing of missile/munition seekers in prototype flexible, multi-product factory.
- (U) Transition design tools and factory control systems for application to a broad range of RF and HPEM applications in military and commercial markets.

D. (U) WORK PERFORMED BY: Contractors will be selected competitively. In-house work will be performed by U.S. Air Force Wright Laboratory; Naval Air Systems Command; U.S. Naval Research Laboratory; U.S. Army Missile Command; U.S. Army Research Laboratory; and National Institute of Standards and Technology.

E. (U) COMPARISON WITH FY 1994 DESCRIPTIVE SUMMARY: Not Applicable.

F. (U) PROGRAM DOCUMENTATION: None.

G. (U) RELATED ACTIVITIES: These programs complement ongoing Technology for Affordability ATDs in Rapid Prototyping of Application Specific Signal Processors (RASSP) and Infrared Focal Plane Array Flexible Manufacturing (IRFPA-FM). AESA will build upon ongoing work in the ARPA sponsored High Density Microwave Packaging for Next Generation Phased Array Radar Program. FDAMMS will build upon ongoing work in the MADE program. These programs are coordinated by the DoD S&T Thrust 7 Technology for Affordability Planning Team.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603739E
PE Title: Electronics Manufacturing Technology
Project Number: MT-08 Date: September 1993
Budget Activity: 2. Advanced Technology Development

J. (U) MILESTONE SCHEDULE:

Plan	Milestones
Jun 94	Award contracts for computer aided design developments, modeling, fabrication and assembly of advanced T/R modules and missile seekers.
Jun 95	Initial demonstrations and benchmarking of integrated product/process development approach for T/R modules and seeker components and higher level assemblies.
Jun 96	Complete development and alpha test of advanced CAD tools, process planners and simulation models. Demonstration of design system application to low end missiles.
Jun 97	Complete design systems and flexible factory systems for AESA and FDAMMS. Demonstrate capabilities to meet cost, cycle-time and quantity requirements.
Sep 98	Deliver final versions of hardware and manufacturing equipment and processes, and transfer technology for both military and commercial use.

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FY 1995-1996 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603739E Project Number: MT-09 (New Start) Date: September 1993
 PE Title: Electronics and Budget Activity: 2. Advanced Technology Development
 Manufacturing Technology

A. (U) RESOURCES: (\$ In Thousands)

Project Title: Dual-use Design and Manufacturing									
Popular	FY 1993	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	To	Total
Name	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Complete	Program
MT-09									
Dual-use Design and Manufacturing Technology	0	0	30,564	49,742	51,751	39,235	20,000	Continuing	Continuing

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENTS AND SYSTEM CAPABILITIES: An essential element of the new defense strategy is dual-use manufacturing. DoD will increasingly rely on commercial production lines to produce military variants of their products for incorporation in weapon systems. This project's focus will be on the flexible process technology including advanced design systems, scalable components and subsystems, advanced materials and processing, flexible factory systems and manufacturing operations control needed to implement this strategy. The program will initiate two Advanced Technology Demonstrations (ATDs) in product areas with a potentially large commercial market. The emphasis will be on achieving the design and manufacturing flexibility required to make low volume Defense access to high volume commercial production economically viable. Both ATDs will include appropriate industry cost sharing.

(U) The two ATDs are Interferometric Fiber Optic Gyroscopes (IFOG) and Dual-Use Manufacturing of Electric Drive Systems (DUEDS). IFOGs are emerging as preferred technology for future commercial inertial navigation applications. The Low Cost IFOG Manufacturing project will develop the large throughput robotic assembly, packaging and testing technologies necessary to fabricate miniature navigation-grade (1 nm/hr) IFOG inertial measurement units (IMUs) at <\$1000 per axis. Miniature navigation-grade IMUs are essential to precision strike weapon systems required to accurately navigate through extended periods of Global Positioning System (GPS) outage due to enemy jamming. Example technology development areas include: (1) low loss, low reflectivity, polarization-preserving optical connectors between optical fiber subassemblies, and optical sources, detectors and miniature integrated optical circuits (MIOCs); (2) rapid,

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FY 1995-1996 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603739E

PE Title: Electronics and Manufacturing Technology

Project Number: MT-09 (New Start)

Date: September 1993

Budget Activity: 2. Advanced Technology Development

precision coil winding machines; (3) geometrically stable, environmentally robust (temperature and vibration) packaging of critical optical subassemblies; (4) large volume MIOC foundry processes; and (5) automatic testing machines.

(U) The Dual-Use Manufacturing of Electric Drive Systems project targets electric drive systems between 20-750 horse power (HP) for demonstration of advanced design and dual-use manufacturing systems. These devices have broad use in DoD and commercial applications and provide a current application for demonstration of dual-use factories. The project will demonstrate Integrated Product/Process Design systems that will integrate performance and manufacturing process requirements for new designs prior to prototyping; factory simulation systems; physics-based models and control systems for processing advanced materials; advanced cost models; flexible and factory planning and control systems for low cost automated manufacture of advanced electric drive systems. This project will leverage significant anticipated industry investment through cooperative efforts which integrate DoD high performance requirements with commercial requirements for low-cost, rapid response and reliability. Dual-use objectives will require concentration on families of subsystems and components designed from the start for flexible manufacturing, and on flexible factory systems.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program: None.

(U) FY 1994 Planned Program: None.

(U) FY 1995 Planned Program:

- (U) Competitive awards for innovative integrated process and product development of components of motors and motor controllers, including design tradeoffs, simulation of component behavior, and planning of flexible manufacturing processes. (\$3.0M)

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FY 1995-1996 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603739E
PE Title: Electronics and Manufacturing Technology
Project Number: MT-09 (New Start) Date: September 1993
Budget Activity: 2. Advanced Technology Development

- (U) Development of new flexible manufacturing concepts, factory control reference architectures, factory models, and intelligent manufacturing resource planning systems. (\$4.0M)
 - (U) Development of innovative materials-based and physics-based manufacturing process models for motor drive components. (\$3.0M)
 - (U) Simulation based design of electric drive systems for aircraft, land combat vehicles, and maritime systems; and prepare specifications for prototypes of electric drive parts and assemblies. (\$5.0M)
 - (U) Conduct IFOG Manufacturing Requirements Assessment. (\$0.6M)
 - (U) Initiate technology developments for precision robotic interconnection of IFOG optical parts and subassemblies; for environmentally robust, optically stable IFOG component and subassembly packaging facilities; for rapid, precision coil winding machinery; for large batch processing MIOC foundry; and for automatic test equipment. (\$15.0M)
- (U) FY 1996 Planned Program:
- (U) Continue integrated process and product development of dual-use families of components for motors and motor controls; demonstrate in a simulated dual-use factory and subsequently in a pilot line. (\$4.2M)
 - (U) Complete development of first phase factory models, intelligent resource planning systems and process and assembly planners for use in intelligent factory control systems. Conduct simulation of dual-use factory for first phase subsystems and components. (\$8.5M)
 - (U) Continue development of materials-based and physics-based manufacturing process models and on-line sensors capable of real time process control. (\$3.5M)

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FY 1995-1996 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603739E

Project Number: MT-09 (New Start) Date: September 1993

PE Title: Electronics and

Budget Activity: 2. Advanced Technology Development

Manufacturing Technology

- (U) Continue development of simulation based design environment for electro voltaic (EV) and electric drive systems for selected aircraft, land combat vehicles, and maritime systems; and prepare specifications for prototypes of electric drive parts and assemblies to be integrated into selected systems. (\$4.5M)
 - (U) Conduct integrated prototype demonstrations of factory control systems in context of specifications provided by vehicle level applications. (\$4.5M)
 - (U) Develop and demonstrate critical element prototypes for precision robotic interconnection of polarization sensitive optical parts and subassemblies; for environmentally robust, optically stable IFOG component and subassembly packaging facilities; for rapid, precision coil winding machinery; for large batch processing MIOC foundry; and for automatic test equipments. (\$24.5M)
- (U) **Program to Completion:**
- (U) Construct and complete a prototype IFOG manufacturing facility.
 - (U) Demonstrate low-rate of production IFOG IMU manufacturing.
 - (U) Transition IFOG manufacturing technologies to defense and civilian contractors.
 - (U) Demonstrate economic viability of flexible production of electric drive systems for military and commercial markets.
 - (U) Transition DUEDS flexible manufacturing technologies for use in dual-use electric drive factories and for other multi-product manufacturing applications.

D. (U) **WORK PERFORMED BY:** This is a new start in FY 1995. Contractors will be selected by competitive awards.

E. (U) **COMPARISON WITH FY 1994 DESCRIPTIVE SUMMARY:** Not applicable.

F. (U) **PROGRAM DOCUMENTATION:** None.

G. (U) **RELATED ACTIVITIES:** These programs complement ongoing Thrust 7 ATDs and are coordinated by the DoD S&T Thrust 7 Technology for Affordability Planning Team. The programs also complement

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FY 1995-1996 BIENNIAL RDT&E DESCRIPTIVE SUMMARY

Program Element: #0603739E
PE Title: Electronics and Manufacturing Technology
Project Number: MT-09 (New Start) Date: September 1993
Budget Activity: 2. Advanced Technology Development

the Hybrid Electric Drive (Alternate Propulsion) project.
H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. (U) MILESTONE SCHEDULE:

	Plan	Milestones
	Jun 95	Award contracts.
	Jun 96	Initial demonstrations of design systems and critical manufacturing processes.
	Jun 98	Demonstrate prototype flexible factory systems.
	Sep 99	Deliver final versions of hardware and manufacturing equipment and processes, and transfer technology for both military and commercial use.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603739E

Project Number: MT-10 Date: September 1993

PE Title: Electronics Manufacturing Technology

Budget Activity: 2. Advanced Technology Development

A. (U) RESOURCES: (\$ In Thousands)

Project Title: Advanced Lithography	FY 1993	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	To	Total
Popular Name	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Complete	Program
MT-10									
Advanced Lithography									
*71,162	47,457	25,000	25,000	25,000	25,000	25,000	25,000	Continuing	Continuing

*Funded under PE 0602712E in FY 1993 and prior years

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: Lithography technology has enabled the dramatic growth of integrated circuit (IC) capability over the past two decades. Advances in lithography lead directly to improvements in electronic and computing systems performance in terms of speed, power, weight and reliability. Advanced microelectronics technology is essential for computing, data and signal processing, and communications for both civilian and military needs. Specific defense applications include smart weapons, radar, electronic warfare, sensing, communications, command and control, and surveillance. Further improvements in areas such as target recognition, autonomous guided missiles and beam forming for sonar and radar will require microcircuits with smaller features in order to meet the power, weight and volume constraints of these systems.

(U) Current microelectronics manufacturing utilizes 0.5 micron minimum feature sizes. This effort develops subsystems and systems to establish manufacturing capability at 0.18 - 0.1 microns for late 1990s manufacturing. Because the optimal cost-effective lithography approach for these future generations of technology is not known today, this effort balances investment in competing approaches with a strong emphasis on the common cross-cutting techniques that will be required. Key developments include mask technology (electron-beam tools for pattern writing, mask fabrication demonstration, mask repair tools, and membranes), improved alignment and overlay techniques, metrology, systems development and

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603739E
PE Title: Electronics Manufacturing Technology
Project Number: MT-10 Date: September 1993
Budget Activity: 2. Advanced Technology Development

integration utilizing various radiation sources (x-ray, electron-beam, ion-beam, and optics), and device demonstrations to establish viability of the developed systems.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program:

- (U) Use x-ray lithography to fabricate 512K SRAM chips with 0.25 micron gate lengths.
- (U) Evaluate diode pumping for the laser plasma x-ray source.
- (U) Develop a multi-shot power supply for the focus plasma x-ray source.
- (U) Complete mask repair tool for masks with 0.25 micron features.
- (U) Release a standard configuration for x-ray masks.
- (U) Initiate efforts in ion-beam and e-beam lithographies directed at prototype systems for 0.18 micron features.

(U) FY 1994 Planned Program:

- (U) Improve cross-cutting technologies (mask, alignment) leading to 0.18 micron design rules, including demonstration of a 50KV e-beam mask writer. (\$15.5M)
- (U) Initiate efforts to migrate the 0.25 micron aligners to 0.18 micron capability. (\$8M)
- (U) Continue efforts in ion-beam, e-beam, and advanced optical lithography, including characterization of the 193 nanometer exposure system. (\$12M)
- (U) Demonstrate 0.25 micron logic device fabrication with proximity x-ray and demonstrate pattern definition with improved projection x-ray system. (\$12M)

(U) FY 1995 Planned Program:

- (U) Deliver EL-4 mask writer and demonstrate subsystems for 0.1 micron writer. (\$6M)
- (U) Evaluate overlay capabilities for 0.18 micron alignment. (\$4M)
- (U) Complete design of step and scan system for projection x-ray. (\$4M)

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603739E
PE Title: Electronics Manufacturing Technology
Project Number: MT-10 Date: September 1993
Budget Activity: 2. Advanced Technology Development

- (U) Demonstrate subsystems for 0.18 micron tools in ion-beam and e-beam writer exposure systems. (\$8M)
- (U) Fabricate devices using the 193 nanometer tool. (\$3M)

(U) FY 1996 Planned Program:

- (U) Demonstrate capabilities for 0.18 micron masks, including inspection and repair. (\$9M)
- (U) Demonstrated capabilities for 0.18 micron alignment. (\$6M)
- (U) Demonstrate 0.18 device fabrication with new technologies (ion, e-beam, advanced optical, or projection x-ray). (\$10M)

(U) Program To Completion:

- (U) Demonstrate a "nanowriter" e-beam tool for writing zone plates with sub-50-nanometer features.
- (U) Demonstrate prototype projection e-beam and ion-beam lithography.
- (U) Demonstrate repair tool for repair of masks with 0.15 micron features.
- (U) Demonstrate stage control for lithography tools with 0.12 micron capability.
- (U) Fabricate devices using soft x-ray reduction techniques.

D. (U) WORK PERFORMED BY: IBM, Essex Junction, VT; Lawrence Berkeley, Berkeley, CA; ETEC, Hayward, CA; University of Wisconsin, Madison, WI; ALG, Rockville, MD; Lockheed-Sanders, Nashua, NH; AT&T, Murray Hill, NJ; and SVGL, Wilton, CT.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603739E Project Number: MT-10 Date: September 1993
PE Title: Electronics Manufacturing Budget Activity: 2. Advanced Technology Development
Technology

E. (U) COMPARISON WITH FY 1994 DESCRIPTIVE SUMMARY: Consistent with FY 1994 Descriptive Summary.

F. (U) PROGRAM DOCUMENTATION: Not applicable.

G. (U) RELATED ACTIVITIES: Not applicable.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. (U) MILESTONE SCHEDULE:

Plan	Milestones
Jun 94	Characterize 193 nanometer optical lithography tool.
Aug 94	Deliver masks from the Microlithographic Mask Development Program.
Jun 95	Demonstrate mask repair tool for masks with 0.15 micron features.
Dec 95	Demonstrate a "nanowriter" e-beam tool for writing features at 50 nanometers.
Sep 96	Fabricate devices with 0.18 micron features.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603744E

PE Title: Advanced Simulation

Project Number: SM-01 Date: September 1993
Budget Activity: 2. Advanced Technology Development

A. (U) RESOURCES: (\$ In Thousands)

Project Title: ARPA/ARNG Advanced Distributed Simulation		FY 1995		FY 1996		FY 1997		FY 1998		FY 1999		Total	
Popular		FY 1993	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 1998	FY 1999	FY 1999	To	Program
Name	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Complete	Program
SM-01	ARPA/ARNG Advanced Distributed Simulation	28,521	9,207	21,431	20,899	14,700	0	0	0	0	0	0	94,759

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: In FY 1992, Congress appropriated funds to initiate a program to apply advanced technology to the training of National Guard Roundout Brigades. This program was initiated to respond to issues that developed in the 1991 Desert Shield/Desert Storm mobilization and has now been integrated as Advanced Technology Demonstration #2 under DoD Science and Technology Thrust #6 (Synthetic Environments).

(U) The goal of the program is to achieve a 200-300 percent increase in National Guard Training Readiness as compared to 1991 through the use of low cost advanced distributed information technologies and innovative training strategies at a cost lower than current Active Component methods for conducting the same training. The intent is to develop and integrate technologies that enable National Guard soldiers to conduct sophisticated training either at the local community armory, or at the soldier's home. The program will capitalize on existing commercial technologies where feasible, and develop technologies where needed with potential dual-use applications in mind.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program:

- (U) Modified and move National Guard Mobile SIMNETs to conduct Task Force operations.
- (U) Established a Reserve Component Virtual Training Center at Fort Knox, KY.
- (U) Initiated development of an affordable table top battle staff synchronization trainer with associated software.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603744E

PE Title: Advanced Simulation

Project Number: SM-01 Date: September 1993

Budget Activity: 2. Advanced Technology Development

- (U) Developed synthetic terrain peculiar to testbed units for use in SIMNET and JANUS 3-D.
- (U) Initiated development of a reconfigurable ground vehicle simulator.
- (U) Initiated development of a location instrumentation and intervehicular communications technology.
- (U) Initiated development of new generation of measures of performance and measures of training readiness.
- (U) Initiated development of program evaluation methodology.
- (U) Initiated development of desktop equipment simulators and advanced technology distributed training capabilities. Priorities will be on the maneuver battalion staff, forward support battalion staff, critical vocational skills of support personnel, brigade staff and small unit leaders. Develop prototype training programs and performance assessment tools for implementation of distributed technologies.
- (U) Initiated modifications to armories to accept technologies to be delivered in FY94/95.
- (U) Continued assessment of promising advanced technologies for integration into program.

(U) FY 1994 Planned Program:

- (U) Continue development of reconfigurable ground simulator and conduct initial functionality test. Upon successful demonstration, continue development as specified in the contract. (\$4.0M)
- (U) Conduct field trials of brassboard location instrumentation and intervehicular communications technology. Upon successful completion of trials, execute partial Phase II effort to develop and test prototypes in unit testbeds. (\$3.9M)
- (U) Continue development of desktop equipment simulators and advanced technology distributed training capabilities. Priorities will be on the maneuver battalion staff, forward support battalion staff, critical vocational skills of support personnel, brigade staff and small unit leaders. (\$1.3M)

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603744E

PE Title: Advanced Simulation

Project Number: SM-01 Date: September 1993

Budget Activity: 2. Advanced Technology Development

(U) FY 1995 Planned Program:

- (U) Connect two test brigades to the Defense Simulation Internet (DSI). (\$2.1M)
- (U) Modify and continue development of previously developed training programs and assessment prototypes. (\$5.0M)
- (U) Continue development of desktop simulators and advanced technology distributed training capabilities. (\$10.0M)
- (U) Continue development of measures and conduct of program evaluation research. (\$4.3M)

(U) FY 1996 Planned Program:

- (U) Operate two test brigades on the Defense Simulation Internet (DSI). (\$1.5M)
- (U) Continue modification and development of training programs and assessment prototypes. (\$5.2M)
- (U) Continue development of desktop simulators and advanced technology distributed training capabilities. (\$9.0M)
- (U) Continue program evaluation research. (\$5.2M)

(U) Program to Completion:

- (U) Operate two test brigades on the Defense Simulation Internet (DSI).
- (U) Complete development of innovative training programs and assessment.
- (U) Complete development of prototype desktop simulators and advanced technology distributed training system.
- (U) Complete program assessment and write final report.

D. (U) **WORK PERFORMED BY:** Bolt, Baranek and Newman, Cambridge, MA; Texas Instruments, Dallas, TX; Loral Corporation, Fort Knox, KY; Orlando, FL; Macon, GA; Seattle, WA; Hewlett Packard Computers, Orlando, FL; Silicon Graphics Inc., Monterey, CA; Sun Microsystems Inc., Monterey, CA; Houston Associates Inc., Arlington, VA, Boise, ID, Fort Leavenworth, KS; BDM Corporation, Monterey, CA, Fort Knox, KY, Fort Benning, GA, Camp Dodge, IA; SESCO Corporation, Arlington, VA; Northwestern University, Chicago, IL; and the Institute for Defense Analyses, Alexandria, VA.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603744E
PE Title: Advanced Simulation
Project Number: SM-01 Date: September 1993
Budget Activity: 2. Advanced Technology Development

E. (U) COMPARISON WITH FY 1994 DESCRIPTIVE SUMMARY: No change.

F. (U) PROGRAM DOCUMENTATION: Currently processing Memoranda of Agreement with the National Guard Bureau; the Army Research Institute for the Behavioral and Social Sciences; the Army Simulation, Targets and Instrumentation Command; and the U.S. Army Armor Center at Fort Knox, KY.

G. (U) RELATED ACTIVITIES: Work in this area is coordinated with the Defense Modeling and Simulation Office (DMSO) which guides DoD policy and ensures that unnecessary duplication does not occur. Direct interaction exists between this program and the Army's TRADOC, FORSCOM, National Guard Bureau and DCSOPS. Related activities are funded in Army Program Element 0604715A, Non-Systems Training Devices.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: None currently exist, but preliminary discussions regarding a joint project with the French are underway.

J. (U) MILESTONE SCHEDULE:

Plan	
Nov 93	
Feb 94	
Feb 94	
Aug 94	
Aug 94	
Aug 94	
Nov 94	
Feb 95	
Feb 95	
Feb 95	

Milestones

Conduct field trials of Phase I MIST-x.
Conduct brassboard evaluation Phase II MIST-x.
Award contract for MIST-x prototype development.
Delivery of proof-of-concept simulator.
Deliver prototype equipment advanced technology training programs.
Deliver first prototype advanced technology training programs.
Establish DSI nodes for two test brigades.
Deliver prototype digital library.
Continue delivery of prototype training programs and assessment tools.
Initiate delivery of prototype equipment simulators.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603744E
PE Title: Advanced Simulation
Project Number: SM-01 Date: September 1993
Budget Activity: 2. Advanced Technology Development

Feb 95	Field trials of assessment tools.
May 95	Deliver draft assessment measures and plan.
Nov 95	Implement program evaluation program.
Nov 95	Begin delivery of prototype digital libraries and programs.
May 96	Implement assessment tools.
Aug 96	Send first experimental brigade to NTC.
Nov 96	Deliver modified training programs from FY96 NTC.
Feb 97	Deliver last equipment simulators.
Aug 97	Send second experimental brigade to NTC.
Feb 98	Deliver final report.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603745E
 PE Title: Microelectronics
 Manufacturing Technology
 Project Number: EM-01 Date: September 1993
 Budget Activity: 2. Advanced Technology Development

A. (U) RESOURCES: (\$ In Thousands)

Project Title: Microelectronics Manufacturing Technology									
Popular	FY 1993	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	To	Total
Name	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Complete	Program
SEMATECH	94,710	100,000	90,000	90,000	90,000	90,000	90,000	Continuing	Continuing

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: The cost-effective capability to manufacture differentiated integrated circuits (ICs) -- i.e., logic, application-specific ICs, microprocessors -- at the state of the art and in any volume with rapid turnaround is vital to the creation of leading-edge information systems. In FY 1993 and beyond, this project is focused at extending the manufacturing capability and on the manufacturing tools and methodologies needed for low-cost, flexible, scalable manufacturing to meet defense and commercial needs. Today's microelectronics manufacturing technology is optimized to produce a single part type in large volumes. This project will combine advances in physical equipment (modular cluster tools with real-time model-based process control, ultra-clean infrastructure, and cost-effective lithography) with software advances (fully integrated computer-integrated manufacturing (CIM) systems and modeling and simulation tools for designing processes, tools, and factories) to enable state-of-the-art microelectronics manufacturing facilities capable of producing many part types in any volume at low cost.

(U) The project builds on the prior SEMATECH effort funded in this project as well as the development efforts in the Microelectronics Manufacturing Science and Technology (MMST) contract in PE 0602712E. SEMATECH comprises the companies that supply the majority of the ICs used in defense systems, and it has a proven track record of working with equipment suppliers effectively. Therefore, SEMATECH will be the primary performer, with continued cost sharing from

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603745E
PE Title: Microelectronics
Manufacturing Technology

Project Number: EM-01 Date: September 1993
Budget Activity: 2. Advanced Technology Development

its member companies. In addition, a small portion of the funds in this project will support related longer-term efforts outside of SEMATECH that enhance the overall goal of achieving cost effective semiconductor manufacturing.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program:

- (U) Initiated projects to produce equipment, materials and factory control systems that will enable the manufacture of high-quality 0.25 and 0.18 micron semiconductor devices.
- (U) Established new technical thrusts in computer modeling and contamination-free manufacturing to extend process capability.
- (U) Expanded development of pollution-preventing, environmentally safe manufacturing processes to drive additional process capability.

(U) FY 1994 Planned Program:

- (U) Develop operations and simulation models for key process equipment and processes, such as plasma etch and lithography. Integrated models to support factory design and operation.
- (U) Develop and transfer equipment and control architectures that optimize utilization. Develop specifications for key production-grade manufacturing equipment and facilities for the 0.18 micron generation.
- (U) Investigate and implement methods to improve the performance of critical process equipment used for manufacture of the 0.5 and 0.35 micron technology generation, using advanced technology such as in-process sensors and implementing standard equipment interfaces. Transfer key process modules and technology for 0.35 micron technology to industry.
- (U) Initiate projects to substantially reduce the contamination of wafers during processing.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Project Number: EM-01 Date: September 1993
Budget Activity: 2. Advanced Technology Development

Program Element: #0603745E
PE Title: Microelectronics
Manufacturing Technology

(U) FY 1995 Planned Program:

- (U) Develop key equipments and unit processes to enable 0.25 micron semiconductor manufacturing.
- (U) Demonstrate factory technology for automated production, including advanced process control.
- (U) Develop models and software that assist in the design of processes and equipment based on first-principles of physics.
- (U) Optimize materials, processes, and equipment for low contaminant, robust manufacturing.
- (U) Demonstrate open factory integration platform for wafer fab, assembly, and test.
- (U) Initiate efforts focused on reducing the sensitivity of manufacturing cost to production volume.
- (U) Develop key components of factory systems capable of responding to process changes with first-pass success.

(U) FY 1996 Planned Program:

- (U) Transfer key equipment for 0.25 micron technology to production facilities. Initiate efforts to develop key equipment and unit processes for 0.18 micron technology.
- (U) Implement a core set of key prototype, intelligent, programmable process tools to demonstrate flexible control and validate software models.
- (U) Develop unit processes and improve equipment designed for next wafer sizes.
- (U) Establish point-of-use chemistry and distribution for contamination-free manufacturing.
- (U) Develop and integrate a set of software tools that support process programmability, and first-pass success manufacturing.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603745E Project Number: EM-01 Date: September 1993
PE Title: Microelectronics Budget Activity: 2. Advanced Technology Development
 Manufacturing Technology

- (U) Demonstrate integration of computers, control software, sensors, and process equipment to facilitate flexible semiconductor factories and manufacturing.
- (U) Program to Completion:
 - (U) Complete factory specifications for a 0.18 micron factory, including equipment, facilities and methods.
 - (U) Complete the material optimization for low-contaminant robust manufacturing process chambers.
 - (U) Optimize micro- and mini-environments for contamination-free manufacturing.
 - (U) Demonstrate open factory integration platform for wafer fab, assembly, and test.
 - (U) Demonstrate fully automated production, including closed-loop process control.
- D. (U) WORK PERFORMED BY: The primary performer is the SEMATECH consortium in Austin, TX.
- E. (U) COMPARISON WITH FY 1994 DESCRIPTIVE SUMMARY: Consistent with the FY 1994 Descriptive Summaries.
- F. (U) PROGRAM DOCUMENTATION: Not applicable.
- G. (U) RELATED ACTIVITIES: Not applicable.
- H. (U) OTHER APPROPRIATION FUNDS: None.
- I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0603745E
PE Title: Microelectronics
 Manufacturing Technology
Project Number: EM-01
Budget Activity: 2. Advanced Technology Development
Date: September 1993

J. (U) MILESTONE SCHEDULE:

Plan	Milestones
Jun 94	Complete a strategy addressing key issues in environmentally safe semiconductor manufacturing.
Dec 94	Develop and transfer unit processes and generic manufacturing methods for integration into production facilities for 0.25 micron features.
Dec 94	Demonstrate operation of critical components of a distributed manufacturing system enabling incremental refinement and supporting tighter process control.
Dec 95	Develop and transfer software tools that reduce overall development cycles through application of modeling and simulation prior to hardware design and development.
Dec 95	Demonstrate the operation of key elements of a fully integrated advance manufacturing system enabling maximum flexibility and rapid response to process modifications.
Dec 96	Develop and transfer unit processes and generic manufacturing methods for integration into production facilities for 0.18 micron features.
Dec 96	Transfer software tools that support flexible manufacturing.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0605898E Project Number: MH-01 Date: September 1993
 PE Title: Management Headquarters Budget Activity: 6. Defensewide Mission Support
 (R&D)

A. (U) RESOURCES (\$ In Thousands)

Project Number & Title	FY 1993 Actual	FY 1994 Estimate	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	To Complete	Total Program
MH-01 Management Headquarters (R&D)	20,762	24,066	25,635	25,993	27,027	27,015	29,507	Continuing	Continuing

B. (U) BRIEF DESCRIPTION OF ELEMENT: This program element provides funding for the administrative support costs of the Advanced Research Projects Agency. This funding provides for the personnel compensation and benefits for civilians as well as costs for building rent, physical and information security, travel, supplies and equipment, communications, printing and reproduction. In addition, funds are included for reimbursing the Military Services for administrative support costs associated with contracts undertaken on the Agency's behalf.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

- (U) FY 1993 Program:
 - (U) Funding under this program element in FY 1993 supported management and administration for the RDT&E program assigned to ARPA. The majority of the funds were required for the pay of personnel who operate the Agency. At the end of the year, additional end strength was transferred to ARPA.
- (U) FY 1994 Planned Program:
 - (U) ARPA will continue the basic management and administrative support efforts for headquarters at approximately the same level as FY 1993. Funding increase reflects full cost of end strength authorization increase in FY 1993 to support additional research efforts and the Defense Reinvestment initiative assigned to ARPA.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0605898E Project Number: MH-01 Date: September 1993
PE Title: Management Headquarters Budget Activity: 6. Defensewide Mission Support
(R&D)

- (U) FY 1995 Planned Program:
 - (U) ARPA will continue the management and administrative support efforts for headquarters at approximately the same level as FY 1994.
- (U) FY 1996 Planned Program:
 - (U) ARPA will continue the management and administrative support efforts for headquarters at approximately the same level as FY 1995. The increased funding reflects no reduction to personnel levels.
- D. (U) WORK PERFORMED BY: Civilian and military personnel assigned to ARPA and by ARPA agent personnel operating within the Military Services.
- E. (U) RELATED ACTIVITIES: Not applicable.
- F. (U) OTHER APPROPRIATION FUNDS: None.
- G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Program Element: #0901600E Project Number: AA-01 Date: September 1993
 PE Title: Contract Administration Budget Activity: 6. Defensewide Mission Support and Audit

A. (U) RESOURCES (\$ In Thousands)

Project Number & Title	FY 1993 Actual	FY 1994 Estimate	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	To Complete	Total Program
AA-01 Contract Administration/Audit	-	27,873	28,371	28,668	28,378	28,096	27,804	Continuing	Continuing

B. (U) BRIEF DESCRIPTION OF ELEMENT: The program element provides funding for the ARPA portion of the Department's estimate for contract audit and management services that will be incurred as a result of contract awards made in this appropriation. These funds will be used to finance Defense Contract Audit Agency (DCAA) and Defense Contract Management Command (DCMC) services that are performed in support of programs budgeted in this appropriation.

(U) This budget presentation reflects a Congressional and Departmental initiative to move toward mission budgeting which calls for an improved method of budgeting and justifying resources. The visibility of total costs related to contract awards and administrative requirements is improved in this presentation because support service funding for related contracts is included in this appropriation.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1993 Program: None.

(U) FY 1994 Planned Program:

- (U) DoD full funding policy for general contract administration support and contract audit management efforts associated with ARPA contracts begins in FY 1994.

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FY 1995-1996 RDT&E BIENNIAL DESCRIPTIVE SUMMARY

Date: September 1993

Program Element: ~~402010000~~
PE Title: ~~Contract Administration~~
and ~~Audit~~

Budget Activity: 6. Defensewide Mission Support

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SECTION III

TECHNOLOGY AREA OF SCIENCE AND TECHNOLOGY PROJECTS

ATD FUNDING PROFILE FY 19 JM

PE/PROJECT	ATD EFFORT	FY93	FY94	FY95	FY96	FY97	FY98	FY99	TOTAL
63589E/AS-01	Active Impedance Modification Magnetic Levitation Advanced Vibration Reducer	1,500 2,500 8,700	3,250						1,500 5,750 8,700
63226E/EE-36	ARTS Shallow Water Multistatic Sonar	4,400 2,000	3,350 4,000	4,000 3,000	3,000 2,000	1,000			14,750 12,000
63226E/EE-39	Autonomous Minehunting & Mapping Fuel Cell Power Systems	3,230 6,900	7,480 3,800	6,400 2,300	4,670	4,400			26,180 13,000
63226E/EE-27	IMPACT	75	3,260	11,435	11,944	12,014	4,031	7,745	50,504
63226E/EE-30	Weapons Sys Applications (WARBREAKER)	7,203							7,203
63226E/EE-37	Simulation Eng Modeling (WARBREAKER)	3,736							3,736
63226E/EE-40	CMT (WARBREAKER)	34,724	104,553	124,654	117,537	114,303	113,162	115,795	724,728
62702E/TT-05	Advanced Targeting Tech (WARBREAKER)	14,663	48,098	36,348	29,876	30,518	34,791	35,597	229,891
63226E/EE-34	GFS	3,721	6,329	10,907	18,937	16,000	15,000		70,894
63226E/EE-37	Synthetic Battlefield on Demand	20,888	39,557	48,251	56,081				164,777
63226E/EE-45	Joint Task Force Command & Control		9,508	19,400	18,900	18,556	17,960		84,324
63226E/EE-CLS	Cruise Missile Area Defense				CLASSIFIED				
63226E/EE-CLS	THORN SHIELD	6,260	14,317	4,667					25,244
63739E/MT-03	Infrared Focal Plane Array Flexible Mfg	15,000	30,000	45,100	43,200	14,400			147,700
63739E/MT-04	ASEM PASSP	8,062 21,410	25,428 37,600	29,458 46,075	29,097 46,075	13,822	12,872	12,872	131,611 151,160
63739E/MT-08	AESA		6,643	19,795	32,855	32,360	13,771		105,424
63739E/MT-08	Missile/Munitions Seeker		5,495	23,280	37,800	32,112	35,920		134,607
63739E/MT-09	FOG			15,564	27,042	27,751	10,935		81,292
		164,972	352,668	450,634	479,014	317,236	258,442	172,009	2,194,975

Active Impedance Modification

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Prepared by: ARPA/MSTO, Mr. Steve McBurnett, (703) 696-2329

Program Elements and Projects	FY93	FY94	FY95	FY96	FY97	FY98	FY99
0603569E/AS-01	1,500	0	0	0	0	0	0

Rationale: The goal of the Active Impedance Modification program is to reduce submarine target strength and radiated noise by using an innovative hull coatings design. This has potential benefits in submarine hydrodynamics, weight reduction, and cost savings by leveraging the ability to utilize commercial off-the-shelf machinery and electronics. This technology is demonstrating materials and control algorithm developments that will radically improve future platforms and can be backfitted to existing submarines. The technology is transitioning to the Office of Naval Research (ONR) in the 3rd quarter of FY 1994.

Significant Milestones:

Event

Complete testing of 1/4 scale panels
Transition AIM to Navy

Dates (Qtr/FY)

2Q/FY94
3Q/FY94

Magnetic Levitation

UNCLASSIFIED

Prepared by: ARPA/MSTO, Dr. Theo Kooij, (703) 696-2333

<u>Program Elements and Projects</u>	<u>FY93</u>	<u>FY94</u>	<u>FY95</u>	<u>FY96</u>	<u>FY97</u>	<u>FY98</u>	<u>FY99</u>
0603569E/AS-01	2,000	3,250	0	0	0	0	0

Rationale: The goal of this advanced technology demonstration is to magnetically levitate the submarine's machinery raft to reduce machinery radiated noise and reduce cost. This will result in an approximate 30 percent reduction in the weight and volume of present machinery designs by eliminating the need for individual sound mounts. The magnetically levitated raft will hold the machinery in precise alignment, obviating the need for expensive precision-built equipment. A further cost savings will be derived from a reduction in the need for expensive sound quieting machinery. In addition, this technology will be exploited to eliminate the need for expensive shock hardened electronic cabinets, which will permit use of relatively inexpensive COTS electronic equipment.

Significant Milestones:

- Event**
- Complete raft fabrication
- Complete DSP fabrication
- Raft demonstration

Dates (Qtr/FY)

- 3Q/FY93
- 3Q/FY93
- 2Q/FY94

Advanced Vibration Reducer

UNCLASSIFIED

Prepared by: ARPA/MSTO, Mr. Steve McBurnett, (703) 696-2329

Program Elements and Projects

	FY93	FY94	FY95	FY96	FY97	FY98	FY99
0603569E/AS-01	8,700	0	0	0	0	0	0
Navy	13,900	18,000	20,000	0	0	0	0
TOTAL	22,600	18,000	20,000	0	0	0	0

Rationale: The Advanced Vibration Reducer program will reduce submarine propulsion-generated radiated noise by modifying the existing thrust and propeller bearing designs. Major advances in critical technologies, such as materials and control algorithms, are being applied to significantly impact future submarine designs and for backfit onto existing platforms. The Advanced Vibration Reducer will be transitioned to the Navy at the end of FY 1993.

Significant Milestones:

Event
 After Application Group Critical Design Review
 Global Controller Critical Design Review
 Transition to Navy
 Full Shaftline Test
 Sea Test

Dates (Qtr/FY)

3Q/FY93
 3Q/FY93
 4Q/FY93
 4Q/FY94
 4Q/FY95

Acoustic Radiator for Tactical Search (ARTS)

UNCLASSIFIED

Prepared by: ARPA/MSTO, Dr. William M. Carey, (703) 696-2314

Program Elements and Projects	FY93	FY94	FY95	FY96	FY97	FY98	FY99
0603226E/EE-36	4,400	3,350	4,000	3,000	0	0	0

Rationale: The shift to low frequency active sonars (LFA) provides several acoustic propagation advantages; however, as the frequency is lowered the transmitter gets larger, and its handling and hydrodynamic drag characteristics become undesirable for tactical operations. The Acoustic Radiator for Tactical Search (ARTS) program will develop and deliver a new transduction material that will enhance the sonar capability of tactical ships by enabling the use of the much lower frequencies required for all-weather sonar activity, breaking the existing size restraint barrier of the transmitting array. The ARTS program has identified a promising polymer material that offers this breakthrough in LFA sonar technology. The unique application of polymers to LFA transduction has resulted in preliminary findings that exceed all original expectations. The material is expected to provide for the construction of low cost, low drag, solid state LFA sonar transmitters.

During phase one of the program, the polyurethane family of polymers was identified as an excellent candidate transduction material. Phase One completed the testing and evaluation of materials selections and provided a quantitative description of cost and performance characteristics in this application. The continued ARTS effort will require two additional phases. Phase Two, currently in its latter stages, consists of selection of a single polymer from the polyurethane family and carrying it forward into designing, building, and testing a scale model of a transmitting array. Phase Three will use the results of Phase Two to design a half wavelength transmitting system suitable for at-sea demonstration of a functioning sonar system. In addition, Phase Three will include the demonstration of a source array system which will be used to conduct a future at-sea demonstration of the full-size array and handling equipment.

Significant Milestones:

Event
 Model Design, Build, Test (Hydrodynamics)
 Model Design, Build, Test (Transducer)
 Acoustic Array Build
 Initial At-Sea Testing
 At-Sea Test/Demonstration of System

Dates (Qtr/FY)

3Q/FY93
 1Q/FY94
 2Q/FY94
 4Q/FY95
 4Q/FY96

UNCLASSIFIED

Shallow Water Multistatic Sonar

Prepared by: ARPA/MSTO, Dr. William M. Carey, (703) 696-2339

Program Elements and Projects	FY93	FY94	FY95	FY96	FY97	FY98	FY99
0603226E/EE-36	2,000	4,000	3,000	2,000	1,000	0	0

Rationale: The likelihood that future naval conflicts will occur in shallow water coastal regions or regions where adverse acoustic conditions exist has placed an increasingly difficult task before U.S. ASW forces. Present active acoustic ASW systems were designed for operation in deep water environments and are not effective in shallow water where high reverberation conditions exist. The Shallow Water Multistatic Sonar Program is developing technologies for a rapidly deployable system that is adaptable for use in a wide range of shallow water/adverse environments.

The shallow water multistatic sonar system concept consists of an innovative low frequency acoustic source, horizontal and vertical receive arrays, and signal and information processors to acoustically tailor the system to the local ocean environmental conditions. Advanced processing algorithms are being developed that will mitigate high reverberation levels characteristic of shallow water. Overall, the system will improve detection capability by accounting for significant signal loss due to multiple interactions with the ocean surface and bottom of the acoustic signal. The source/receiver/processing system that is developed will demonstrate the ability to conduct ASW under shallow water/adverse environmental conditions from tactical platforms. A highly successful sea test was conducted in September 1992. Current program efforts are focused on sea test data analysis and preparation for a sea test in a different area beginning in September 1993 involving a bottomed submarine target.

Significant Milestones:

Event

Area Characterization Test II
 Exploratory Development System Prototypes
 Area Characterization Test III
 Receive/Process System Design, Development, Upgrade and Integration
 Complete Technology Demonstration and System Design and Development
 At-Sea Demonstration
 Complete System Upgrade
 Final At-Sea Demonstration

Dates (Qtr/FY)

4Q/FY93
 2Q/FY94
 4Q/FY94
 1Q/FY95
 2Q/FY95
 4Q/FY95
 4Q/FY96
 1Q/FY97

Autonomous Minehunting & Mapping

UNCLASSIFIED

Prepared by: ARPA/MSTO, CAPT Alan R. Beam, (703) 696-2338

Program Elements and Projects	FY93	FY94	FY95	FY96	FY97	FY98	FY99
0603226E/EE-39	3,230	7,480	6,400	4,670	4,400	0	0

Rationale: The objective of the Autonomous Minehunting and Mapping (AMM) Program is to develop and demonstrate an Unmanned Undersea Vehicle (UUV) mine mapping capability in the shallow water environment. The AMM system will covertly obtain precise bottom topography, mine, obstacle, and environmental information that will be used to select possible amphibious operating areas, expedite special forces operations or enable subsequent, rapid mine neutralization. Once developed, this capability will also be applicable for commercial undersea environmental survey and sampling. Development of the acoustic navigation system will be critical to the performance of the AMM system. The AMM system will also incorporate advanced artificial intelligence scene description and understanding. An optical imaging system will be installed to obtain an image of objects which the sonar cannot classify. All data collected will be compressed and recorded for transfer to the host platform. The Phase I at-sea demonstration is scheduled for FY 1994; final demonstration will occur in FY 1997 prior to transition to the Navy UUV Program Management Office (PMO403).

Significant Milestones

Event
 Requirements definition completed
 Phase I System development and UUV integration completed
 Phase I System at-sea test
 Phase I System demonstration
 UUV Minehunting/Mapping Technology Demonstration
 Transition to Navy

Dates (Qtr/FY)

3Q/FY93
 2Q/FY94
 3Q/FY94
 4Q/FY94
 3Q/FY97
 4Q/FY97

Fuel Cell Power System

UNCLASSIFIED

Prepared by: ARPA/MSTO, Dr. Robert L. Rosenfeld, (703) 696-2327

Program Elements and Projects	FY93	FY94	FY95	FY96	FY97	FY98	FY99
0603226E/EE-39	6,900	3,800	2,300	0	0	0	0

Rationale: The goal of the fuel cell technology program is to develop a fuel cell power system with an energy density three times greater than the batteries currently powering the ARPA Unmanned Undersea Vehicle (UUV). The goal includes demonstration of the fuel cell system as a transparent replacement for the UUV batteries. The fuel cell power systems are required to provide energy for long endurance UUV missions such as minefield mapping and mine search. Two contractors are competitively developing two brassboard systems. International Fuel Cell (IFC) in Hartford, CT is developing a hydrogen and oxygen fueled system using a Proton Exchange Membrane (PEM) fuel cell stack. The second contractor, Loral of Akron, OH with Eltech of Fairport Harbor, OH is developing an Aluminum-Oxygen semi-cell system. It is expected that the aluminum-oxygen system will be selected for installation in an ARPA UUV and for at-sea test and evaluation. A solid fuels program was started in FY 1993 to develop reactants that are safer to use in closed environments.

Significant Milestones:

Event
 PEM Power Plant Demonstration (1/2 power)
 Aluminum-Oxygen Power Plant Critical Design Review
 Aluminum-Oxygen Power Plant Demonstration (Full power)
 Begin Installation in ARPA UUV
 Complete Sea Trial
 Transition to Navy

Dates (Qtr/FY)

4Q/FY93
 1Q/FY94
 3Q/FY94
 1Q/FY95
 4Q/FY95
 1Q/FY96

Format C-7c: Applied Technology (1 Position) Demonstration (ATD/ATPD)

Insertion into MILSATCOM Products of Advanced Communications Technologies (IMPACT)

UNCLASSIFIED

Prepared By: ARPA/ASTO, LtCol Lee Demitry, (703) 696-2303

Program Elements and Projects:	FY93	FY94	FY95	FY96	FY97	FY98	FY99
0603226E/EE-27	75	3,260	11,435	11,944	12,014	4,031	7,745

Rationale: IMPACT is a multidisciplinary development program aimed at leveraging advanced technologies to reduce the life-cycle costs of the MILSATCOM terminal segment with associated reductions in size, weight and power consumption and enhanced interoperability, performance, reliability and capabilities. The program addresses broad technology efforts that span all MILSATCOM terminal programs with technology initiatives in support of next-generation terminals.

IMPACT technology will improve the affordability and performance of MILSATCOM terminals in a number of areas. Life-cycle personnel costs will be reduced via development of an autonomous artificial intelligence terminal controller. Maintenance and logistics costs will be reduced by leveraging advanced microelectronics for enhanced terminal availability and graceful degradation. Seamless and affordable interoperability will be possible with existing MILSATCOM systems, as well as commercial SATCOM access via multiband (UHF, L-band, C-band, SHF), multimode terminals to directly support the Joint Staff "C4I for the Warrior" program. Strategic and tactical mobility will be enhanced through miniaturization of terminals requiring less power and providing enhanced "common-on-the-move" capability. High performance and advanced capabilities necessary to support the global Grid communications infrastructure will be developed. IMPACT will develop technologies to a point at which they are ready for incorporation into next-generation systems. Technology developments will be demonstrated as an integrated suite of advanced subsystems packaged as an affordable, high-performance testbed terminal to serve as a pathfinder for next-generation systems. IMPACT will develop testbed terminals that specifically address the most important, high-leverage, technology-based advancements for affordable, next-generation capabilities.

Significant Milestones:

Event
BAA Source Selection
BAA contract awards
Completion of BAA technology projects
RFP released for Testbed Terminal Integration
Testbed Terminal Source Selection
Testbed Terminal contract awards
Complete Testbed Terminal fabrication
Complete Testbed Terminal demonstration

Dates (Qtr/FY)

4Q/FY93
1Q/FY94
FY94-FY98
2Q/FY97
3Q/FY97
4Q/FY97
4Q/FY98
4Q/FY99

WAR BREAKER

UNCLASSIFIED

Prepared by: ARPA/ASTO, Mr. Charles Heber, (703) 696-2304

Program Elements and Projects	FY93	FY94	FY95	FY96	FY97	FY98	FY99
0603226E/EE-40	34,724	104,553	124,654	117,537	114,303	113,162	115,795
0602702E/TT-05	14,663	48,098	36,348	29,876	30,518	34,791	35,597
0603226E/EE-30	7,203	0	0	0	0	0	0
0603226E/EE-37	3,736	0	0	0	0	0	0

Rationale: Prosecution of time-critical fixed and mobile targets has long been a concern of the Services as evidenced by past efforts in the areas of Strategic Relocatable Targets and Smart Weapons. Recent experience in Desert Storm has dramatically demonstrated our current inability to prosecute these targets, particularly Tactical Ballistic Missiles (TBMs). DARPA's WARBREAKER program will develop advanced technology and systems to enable the detection, identification and prosecution of a wide range of high value, time-critical fixed and mobile targets including TBMs, mobile command posts, tanks and artillery. This project will develop, mature and integrate advanced technologies and develop and demonstrate system concepts supporting the prosecution of these targets. Key areas include advanced surveillance, target acquisition, automatic target detection and recognition, automated intelligence correlation, battlefield management, information distribution and terrain data generation technologies. This project is part of the ARPA contribution to the DoD Advanced Technology Demonstrations within the Global Surveillance and Communications and Precision Strike DDR&E thrust areas.

Significant Milestones:

Event	Dates (Qtr/FY)
Complete Mustrs system/subsystem hardware fabrication.	4Q/FY93
Complete Mustrs captive flight test.	3Q/FY94
Complete WAR BREAKER distributed simulation.	2Q/FY95
Demonstrate automapping capability using IFSAR.	1Q/FY95
Initial demonstration of automatic cue development from contextual analysis of MTI radar data.	1Q/FY95
Demonstrate technology to build and distribute over a wide area network, terrain and feature and intelligence and object data for a 1 million square KM theater.	1Q/FY97
Demonstrate integrated intelligence correlation and battle management to facilitate local attack control.	1Q/FY97
Demonstrate capability to correlate all-source intelligence to detection, tracking, targeting, and destruction of time critical targets.	1Q/FY98
Conduct integrated wide area/focused surveillance system demonstration.	3Q/FY98
Demonstrate multi-spectral and IFSAR processing feature extraction and elevation data fusion and real-time modification of theater terrain data.	4Q/FY98
Conduct fully integrated WAR BREAKER demonstration	3Q/FY99

UNCLASSIFIED

GPS Guidance Technologies

Prepared by: ARPA/ASTO, Maj. Beth M. Kaspar, (703) 696-2367

Program Element and Projects	FY93	FY94	FY95	FY96	FY97	FY98	FY99
0603226E/EE-34	3,721	6,329	10,907	18,937	16,000	15,000	0
0603311F	1,600	1,200	0	0	0	0	0
TOTAL	5,321	7,529	10,907	18,937	16,000	15,000	0

Rational: Fire-and-Forget stand-off weapons need precise targeting information if time-critical fixed and mobile targets are to be eliminated effectively and with minimal collateral damage. This requires that: (1) military surveillance and targeting systems geo-locate targets accurately in the same targeting grid that the weapon system navigates in; (2) the weapon system has a precision navigation and guidance system on-board, plus an effective endgame seeker; and (3) both capabilities operate day/night and in adverse weather. In addition, future systems designed to accomplish this capability must be significantly more affordable. The achievement of these characteristics in an integrated system based on advanced navigation and guidance technologies is the goal of this program.

This project develops and exploits the emerging affordable technologies in miniature Global Positioning System (GPS) receivers (MGRs); all solid-state gyroscopes and accelerometers; and miniature atomic clocks, to facilitate the desired precision targeting and weapon delivery concept (Common Grid). Specific research areas include the following: (1) advanced all solid-state, low-cost navigation-grade, interferometric fiber optic gyroscope (IFOG) miniature inertial measurement units (MIMUs); (2) multi-channel-on-a-chip, high-dynamics MGRs; (3) low cost differential GPS local broadcast stations; and (4) affordable endgame seeker technologies. This project also contains two of the DoD Advanced Technology Demonstration (ATDs) in the Precision Strike Thrust area. The ATDs are called GGP and Common Grid.

The GPS Guidance Package (GGP) tightly integrates a MGR, and a MIMU with an advanced navigation computer into a potentially low-cost, precision navigation system. GGP Phase 1 addresses the technology issues involved in; (1) miniaturizing inertial-grade IMUs into a compact, manufacturable configuration; and (2) developing a multi-channel-on-chip, high dynamics MGR. Upon successful demonstration of these technologies, they will be integrated into a brassboard for field testing and evaluation by ARPA and the Service elements. Phase 2 will demonstrate the compact, affordable packaging of these technologies into a form compatible with a large range of unmanned and manned platforms, satellites and weapon systems. GGP Phase 2 units will meet more stringent environmental requirements and have a lower cost. The Manufacturing for Affordability Thrust is focusing on the cost driver for GGP, IFOG manufacturing, and has a comprehensive program to reduce production costs.

Common Grid improves the standard GPS world-wide accuracy to less than 3 meters in location and 15 nanoseconds in time over a battlefield service area with a diameter exceeding 100 kilometers.

Common G... supplements the primary GPS system (on a non-interference basis), with a set of portable theater... employed, battlefield-wide precision differential GPS (DGPS) transmitters providing broadcast service to authorized high dynamic users. The portable DGPS reference station combines an advanced, precise-service, GPS receiver with (1) a miniature tactical atomic clock, (2) a geo-physics self surveying software suite with a micro-processor, (3) communications equipment for networking and (4) a low power broadcast transmitter. Authorized users combine their standard GPS data with the Common Grid geo-reference broadcast data to achieve a World Geodetic System -1984 (WGS-84) precision refinement of their current location on the common grid.

Significant Milestones:

Event

GGP Test Readiness Review
 GGP Phase 2 Award
 GGP Phase 1B Contractor Tests
 Phase 1 Brassboard Delivery
 Govt Brassboard Tests Begin
 GGP Phase 2 Preliminary Design Review
 GGP Phase 2 Critical Design Review
 Common Grid System Feasibility Demonstration
 Phase 2 Contractor Testing
 Common Grid Brassboard Demonstration
 Phase 2 Brassboard Delivery
 Government Brassboard Tests Begin

Dates (Qtr/FY)

1Q/FY94
 3Q/FY94
 4Q/FY94
 4Q/FY94
 4Q/FY94
 3Q/FY95
 2Q/FY96
 2Q/FY96
 3Q/FY97
 4Q/FY97
 1Q/FY98
 1Q/FY98

Synthetic Theater of War

Prepared by: ARPA/ASTO, Col Robert Reddy (703) 696-2362

Program Elements and Projects:	FY93	FY94	FY95	FY96	FY97	FY98	FY99
0603226E/EE-37	20,888	39,557	48,251	56,081	0	0	0

Rational: The Advanced Distributed Simulation program develops advanced interoperable technologies to enable a distributed, seamless warfighting simulation environment at the weapon level of detail. The ultimate goal is to provide the tools and standards necessary to create, on demand, a robust synthetic theater of war capable of supporting the following functions: Joint/Service readiness training, Joint/Service Doctrine refinement and development; requirements analysis; design, prototyping and manufacturing; and contingency planning, operations, after action review, and historical analysis. The focus is on the development and integration of key technologies such as environmental representation, intelligent computer generated forces, communications (advanced networking) and data flow, range instrumentation, and computer image exercises of increasing size, mature, they will be demonstrated and tested in joint theater war exercises of increasing complexity and utility that will simulate all the functionalities on a seamless electronic battlefield. The synthetic environment will prepare our leaders and forces for any variety of warfare and will be deployable to support forces in the field. The Advance Simulation Technology developments support the DDR&E Science and Technology Thrust Panel for Synthetic Environments.

Significant Milestones

Event

Demonstrate communications and data flow technologies supporting 10,000 weapon platforms as individual objects on the synthetic battlefield.

Demonstrate improved intelligent automated forces.

Demonstrate real to virtual connectivity on an instrumented range.

Demonstrate in a joint theater of war a seamless land/sea/air warfighting simulation environment representing operation with a high degree of realism, fully integrated and supporting service, and joint operational concept.

Demonstrate engineering feasibility of low cost computer image generation technology.

Demonstrate Rapid terrain generation capability.

Provide production prototype Low cost computer image generator.

DATES (QTR/FY)

2Q/FY94

3Q/FY94

4Q/FY94

1Q/FY95

2Q/FY95

3Q/FY95

4Q/FY96

UNCLASSIFIED

Prepared by: ARPA/SISTO, Mr. John Shill, (703)-696-2222

Program Elements and Projects	FY93	FY94	FY95	FY96	FY97	FY98	FY99
060322E/EE-45	0	9,508	19,400	18,900	18,556	17,960	0

Rational: The Portable Command and Control for the Joint Task Force (JTF) Advanced Technical Demonstration (ATD) will focus on enabling a new two tier operations doctrine for the JTF, by focusing technology investment on scalable and constantly improving warfighter functionality. The users will be provided a common picture of a crisis and the resources available to use in the crisis. The users will be supported by an interoperable set of flexible and evolvable software tools that support joint operations. The JTF will have available the full set of emerging global grid services that provide portable communication and intelligent information services. The strategy of combining a new operations doctrine and acquisition process, and providing critical global grid information services satisfies deployable JTF requirements. The rationale for this ATD is that it develops, tests, and transitions necessary technology for advanced command and control systems such as the Global Command and Control System. Demonstrations will be conducted with the unified commands and their components in real exercises.

**Significant Milestones
Event**

Broad Agency Announcement
 Source Selection for software architecture team and Global Grid Services team
 Contract Award - Initial design review and demonstration
 USPACOM exercise
 Design Specifications for software architecture and Global Grid Services
 Broad Agency Announcement for Portable C4I Demos
 Multiple crisis, global grid and software architecture tests
 Source Selection for Portable C4I Demos
 DSI and ATDNet Evaluation
 Contract Award
 Interoperability demonstration with service C4I
 Multiple CINC demonstration

DATES (QTR/FY)

4Q/FY93
 1Q/FY94
 2Q/FY94
 4Q/FY94
 4Q/FY94
 2Q/FY95
 4Q/FY95
 4Q/FY95
 4Q/FY95
 4Q/FY95
 4Q/FY96
 4Q/FY97

Cruise Missile Area Defense

UNCLASSIFIED

Prepared by: ARPA/SPO, Mr. Thomas Swartz, (703) 243-9588

<u>Program Elements and Projects</u>	<u>FY93</u>	<u>FY94</u>	<u>FY95</u>	<u>FY96</u>	<u>FY97</u>	<u>FY98</u>	<u>FY99</u>
0603226E/EE-CLS				CLASSIFIED			
0603238A/D189	12,700	1,000	1,000	12,000	16,400	24,300	16,300

Rationale: Air Defense/Air Superiority was identified as one of the seven Science and Technology Thrust areas established in August 1991, and the need for a robust point and area defense against cruise missiles was identified as one of the necessary Advanced Technology Demonstrations (ATDs). The services, as well as the Advanced Research Projects Agency (ARPA), have been aggressively pursuing technology necessary to counter the cruise missile threat. To date, the work has been limited to the development of individual components and subsystems which would either be used in a totally new air defense system or as a product improvement to existing systems. This ATD will integrate several of these on-going developments into a full end-to-end live-fire demonstration of cruise missile defense.

The curvature of the earth and terrain obstacles limit the intercept range of a totally ground based target acquisition and fire control system to approximately 25 kilometers for a terrain following cruise missile. Coupling an airborne radar with the ground based missile system in the ATD will largely eliminate terrain masking effects and thereby significantly increase the defended area against low flying cruise missiles.

Significant Milestones
Event
CLASSIFIED

DATES (QTR/FY)

Thorn Shield

UNCLASSIFIED

Prepared By: ARPA/ASTO, Mr. Harry Berman, (703) 696-2310

Program Elements and Projects: FY93 FY94 FY95 FY96 FY97 FY98 FY99

0603226E/EE-CLS 6,260 14,317 4,667 0 0 0

Rationale: This is a Special Access Program.

Significant Milestones:
Event

Dates (Qtr/FY)

Classified

Infrared Focal Plane Array Flexible Manufacturing

UNCLASSIFIED

Prepared by: ARPA/MTO, Mr. Raymond Balcerak, 703-696-2277

Program Elements and Projects	FY93	FY94	FY95	FY96	FY97	FY98	FY99
0603739E/MT-03	15,000	30,000	45,100	43,200	14,400	0	0

Rational: The objective of this program is to establish a scalable infrared focal plane array fabrication capability which can respond to rapidly changing system requirements by producing sensors at affordable cost, independent of the production volume. The capability will encompass infrared semiconductor manufacturing, cryogenic packaging, sensor assembly, integrated into a factory control system. The infrared semiconductor and electronics factory will be built upon a modular approach to infrared sensor manufacturing, expanding upon concepts in the silicon industry. Semiconductor processes, currently performed sequentially with specialized equipment will be combined into cluster tools capable of performing multiple processes in a controlled environment. Wafer-at-a-time processing will be emphasized with the yield and cost commensurate with higher volume manufacturing. Variations in infrared sensor design will be demonstrated in the same manufacturing lot, and even on the same wafer. Both the infrared semiconductor processes and the cryogenic assembly will be based upon process models which form the basis for the process control system and permit accurate simulations of the manufacturing of new designs. Assembly workstations, employing models of the cryogenic package configurations, will be developed to adapt the assemble procedure to new designs, reducing both the cycle time and cost to realize new infrared sensor designs. The capability to process both three-to-five and eight-to-twelve micrometer arrays, in both scanning and staring configurations, at low volume, will be demonstrated with the process scalable to high production volume as necessary.

Significant Milestones

Event	DATES (QTR/FY)
Demonstrate feasibility of a process module for infrared focal plane array manufacturing	4Q/FY93
Laboratory demonstration of the configuration independent semiconductor manufacturing tools capable of producing three-to-five and eight-to-ten micron arrays.	3Q/FY94
Demonstration of high density staring infrared focal plane array, using dry semiconductor processing in a modular cluster tool.	2Q/FY95
Demonstration of reduction in cycle time for array operation at 77K-200K with both three-to-five and eight-to-ten micron spectral response.	2Q/FY96
Completion of modular infrared focal plane array manufacturing capability, scalable from low volume (single wafer processing) to higher production volume (ten wafer lots at over 10,000 wafers per year); with single wafer cycle time of ten days.	1Q/FY98

Application Specific Electronic Modules (ASEM)

UNCLASSIFIED

Prepared by: ARPA/ESTO, Dr. Nick Naclerio, (703) 696-2216

Program Elements and Projects	FY93	FY94	FY95	FY96	FY97	FY98	FY99
0603739E/MT-04	8,062	25,428	29,458	29,097	13,822	12,872	12,872

Rationale: The objective of this program is to shorten the time required for electronic module design, manufacture, test, acquisition and insertion as well as increasing the overlap and feedback between each of the phases. Reductions in module development and acquisition lead times defers selections of particular implementation technologies until later in the design cycle thereby permitting more timely insertion of state-of-the-art electronic modules that will reduce the cost and improve the performance of weapon systems. New capabilities that facilitate flexible, low volume access to high volume commercial production facilities and distributed teaming of component suppliers and integrators will enable maximum leverage of the domestic industrial infrastructure.

Significant Milestones:
Event

Demonstrate the ability to electronically transmit multi-chip module designs to multiple commercial foundries and receive completed modules in less than 2 months.

Demonstrate a manufacturing capability to produce high-performance multi-chip modules (over 250 MHz) with non-recurring engineering (NRE) costs of less than \$25,000, and substrate costs of less than \$25 per square inch.

Demonstrate foundry capability for flexible production of modules with broad-level integration.

Dates (Qtr/FY)
4Q/FY94
1Q/FY95
3Q/FY96

Rapid Prototyping of Application Specific Signal Processors (RASSP)

UNCLASSIFIED

Prepared by: ARPA/ESTO, Dr. Mark A. Richards, (703) 696-2253

Program Elements and Projects

	FY93	FY94	FY95	FY96	FY97	FY98	FY99
0603739E/MT-04	21,410	37,600	46,075	46,075	0	0	0

Rationale: The goal of the Rapid Prototyping of Application Specific Signal Processors (RASSP) program, a new ARPA/tri-Service effort, is dramatic reductions in the development lead time of advanced signal processing capability used in DoD systems such as those for automatic target acquisition, tracking and recognition, electronic countermeasures, communications, and SIGINT. Timely availability of such advanced signal processors will result in substantial cost reductions for DoD systems through elimination of the necessity to make major changes in both hardware and software when performance improvements are incorporated. Early incorporation will also standardize equipment, interfaces, and software, resulting in lower logistics and support costs.

Significant Milestones:

Event

Award primary development contracts
 Demonstrate first version of RASSP design environment
 Fabricate and test first RASSP signal processing circuits
 First virtual prototype system demonstration design
 Complete advanced applications to several DoD systems

Date (Qtr/FY)

4Q/FY93
 1Q/FY94
 2Q/FY94
 3Q/FY94
 4Q/FY96

Active Electronically Scanned Arrays (AESA)

UNCLASSIFIED

Prepared by: ARPA/ESTO, Mr. Elliot D. Cohen, (703) 696-2214

Program Elements and Projects	FY93	FY94	FY95	FY96	FY97	FY98	FY99
0603739E/MT-08	0	6,643	19,795	32,855	32,360	13,771	0

Rationale: The goal of the Active Electronically Scanned Array (AESA) program, a new ARPA/tri-Service effort, is to accelerate progress toward producing and fielding affordable electronically scanned arrays for the next generation of aircraft, missiles, satellites, ships, ground installations and vehicles. The program will focus upon improved module and array designs that are low cost, easy to manufacture and assemble, that reliably meet the performance requirements of intended applications, are adaptable to a wide range of platforms, are light weight, and are physically compact. The program will put into place the required capabilities and methodologies for adaptable, mixed rate production and assembly of T/R modules and arrays. The program will culminate with demonstrations of the effectiveness of the processes, manufacturing approaches and products that are developed.

Significant Milestones:

Event

Begin work on integrated computer aided design/computer aided manufacturing/
computer aided test tools and techniques

Develop preliminary array designs

Develop specifications for and layout of adaptable factory

Develop improved design tools and integrate database information

Develop automated equipment for faster, lower cost testing

Develop adaptable factory workstations and interfaces

Demonstrate low cost, high performance T/R modules and subarrays

Demonstrate completed high rate, adaptable production capabilities

Demonstrate performance and cost effectiveness of AESA arrays

Date (Qtr/FY)
4Q/FY94

4Q/FY94

4Q/FY94

4Q/FY95

2Q/FY96

4Q/FY96

4Q/FY97

2Q/FY98

2Q/FY98

FLEXIBLE DESIGN AND ASSEMBLY OF MISSILE/MUNITION SEEKERS (FDAMMS)

UNCLASSIFIED

Prepared by: ARPA/SSTO, Dr. Michael McGrath, (703) 696-2224

<u>Program Elements and Projects</u>	<u>FY93</u>	<u>FY94</u>	<u>FY95</u>	<u>FY96</u>	<u>FY97</u>	<u>FY98</u>	<u>FY99</u>
0603739E/MT-08	5,495	23,280	23,280	37,800	32,112	35,920	0

Rationale: The FDAMMS program will demonstrate the feasibility and benefits of an enterprise level integrated system for design and manufacture of complex electro-mechanical systems, such as missile and munition seekers. The goal is to achieve significant reductions in cost and cycle time through integrated product/process development, and flexible parts supply and assembly processes that are efficient for low volume manufacturing. FDAMMS will develop, integrate, and demonstrate automated design-for-assembly tool, process planning and control system, advanced factory simulation, and flexible high precision assembly and checkout system usage in various precision electro-mechanical subsystems and components. The resulting dual-use process technologies will be implemented by FDAMMS team members in commercially available software tools and factory systems. By 1998 a prototype flexible factory for designing and assembling complex electro-mechanical assemblies will be operational, and a final integrated system demonstration will be conducted on a missile or munition guidance and control system. This program complements ongoing advanced technology demonstration projects including the Rapid Prototyping of Application Specific Signal Processors and Infrared Focal Plane Array Flexible Manufacturing. Critical enabling technologies to be employed include design automation, high performance computing and communications, software technology, and advanced materials and processes.

Significant Milestones:

Event	Dates (Qtr/FY)
Award contracts for computer-aided engineering environments, modeling, fabrication and assembly of precision electro-mechanical systems.	3Q/FY94
Initial demonstrations and benchmarking of integrated product/process development for precision electro- approachmechanical components and higher level assemblies.	3Q/FY95
Complete development and alpha test of advanced CAD tools, process planners and simulation models.	3Q/FY95
Complete flexible factory systems for FDAMMS. Demonstrate capabilities to meet cost, cycle time and quantity requirements.	3Q/FY96
Conduct integrated system demonstration on a missile or munition seeker. Deliver final versions of software and manufacturing equipment and processes, and transfer technology for both military and commercial use.	4Q/FY98

Interferometric Fiber Optic Gyroscope (IFOG) Manufacturability

UNCLASSIFIED

Prepared by: ARPA/ASTO, Maj. Beth M. Kaspar, (703) 696-2367

Program Element and Project	FY93	FY94	FY95	FY96	FY97	FY98	FY99
0603739E/MT-09	0	0	15,564	27,042	27,751	10,935	0

Rational: Precision gyroscopes, or more formally, rotation rate sensors, are the key inertial instruments used in enormously varied applications for guidance, navigation, vehicle orientation, attitude control, and sensor orientation/stabilization. For example, this grade of gyroscope is required for high precision navigation and guidance over long distances. Precision gyroscopes are important for those weapon and avionics systems integrated with a NAVSTAR Global Positioning System (GPS) receiver. ARPA is currently pioneering the development of a small, all solid state precision navigation package composed of a miniature GPS receiver, an interferometric fiber optic gyroscope (IFOG) based inertial measurement unit and a high speed navigation computer. IFOG technology was chosen for its potential to achieve significant cost reduction and greatly increased system reliability, relative to other precision rotation rate sensing technologies.

Current navigation grade gyroscopes are relative heavy, bulky and expensive. Most military system designers use ring laser gyroscopes (RLGs). Precision RLGs cost about \$25,000 each, weigh about 6 lbs. and occupy about 150 in³. IFOG technology holds the promise of less than \$500 per axis production costs, with weight and volume at 1 lb and 30 in³, respectively.

The objective of this ATD is to develop and demonstrate the necessary, high optical quality robotic assembly and test machinery to produce in large volume, navigation grade IFOG instruments at a cost goal of under \$500 each. Ideally, production time should be under a week, and preferably less than a day with a minimum of labor. Because of the modular nature of IFOGs, the same manufacturing equipment can be used to produce lesser performance gyroscopes at even lower unit cost. Much of this effort contributes directly to enhancing US industry competitiveness in the worldwide gyroscope market.

Significant Milestones:

Event
Initiate Preliminary Design Phases
Complete Preliminary Designs
Complete Feasibility Breadboard Demonstrations
Complete Prototype Machine Demonstrations
Initiate Low Rate Initial Production (LRIP) Demonstration, Full Instruments
Complete LRIP Demonstration

Dates (Qtr/FY)

1Q/FY95
4Q/FY95-2Q/FY96
3Q/FY96-2Q/FY97
3Q/FY97-1Q/FY98
3Q/FY97
4Q/FY98

SECTION III

TECHNOLOGY AREA OF SCIENCE AND TECHNOLOGY PROJECTS

**Technology Area of Science and Technology Projects
Advanced Research Projects Agency**

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: MANAGEMENT HEADQUARTERS

	FUNDING PROFILE (\$, 000)		
<u>Program Element/Project/Title</u>	<u>FY 1994</u>	<u>FY 1995</u>	<u>Percent Change</u>
65898E/MH-01/Management Headquarters	24,066	25,635	7%
65898E/AA-01/Contract Administration/Audit	27,873	28,371	2%
Total	51,939	54,006	4%

Rationale: This technology area funds ARPA Management Headquarters administrative support costs including personnel salaries, building leases, physical security, and travel. A minor (\$1.6 million) increase for Management Headquarters activities is required to fund additional IPA billets needed to execute ARPA's expanded responsibilities in managing the Balanced Technology Initiative, Air Defense Initiative, and Defense Technology Reinvestment Program.

**Technology Area of Science and Technology Projects
Advanced Research Projects Agency**

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: SPECIAL ACCESS PROGRAMS

	FUNDING PROFILE (\$, 000)		Percent Change
<u>Program Element/Project/Title</u>	<u>FY 1994</u>	<u>FY 1995</u>	
63226E/EE-CLS/Classified-ADI	215,168	207,939	-3%
65114E/BL-01/Blacklite	4,875	4,875	0%
Total	220,043	212,814	-3%

Rationale: The \$7.2 million decrease reflects a reprioritization of funding requirements.

Technology Area of Science and Technology Projects **Advanced Research Projects Agency**

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: COMMAND, CONTROL, COMMUNICATIONS

FUNDING PROFILE
(\$, 000)

<u>Program Element/Project/Title</u>	<u>FY 1994</u>	<u>FY 1995</u>	<u>Percent Change</u>
62301E/ST-01, JASONS Studies	1,240	1,227	-1%
62702E/TT-03, Naval Warfare Technology	33,828	39,883	18%
63226E/EE-45, Global Grid Communications	20,881	42,843	105%
Total	55,949	83,953	50%

Rationale: The Command, Control, and Communications technology area increases by \$28.0 million in FY 1995. Of this amount, \$22.0 million is attributable to increased funding requirements for the Global Grid Communications ATD that will develop and demonstrate advanced communications technologies needed for defense and intelligence operations for the 21st century. The program will demonstrate that commercial communication resources and technologies can be integrated with advanced optical components developed in this program as well as DoD tactical and satellite technologies developed in other programs. The remainder of the increase is associated with prototype development and testing activities in the three Naval Warfare Technology programs, Simulation-Based Design, Ship Systems Automation and C3I/Synthetic Environments.

**Technology Area of Science and Technology Projects
Advanced Research Projects Agency**

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: SENSORS

**FUNDING PROFILE
(\$, 000)**

<u>Program Element/Project/Title</u>	<u>FY 1994</u>	<u>FY 1995</u>	<u>Change</u>
62301E/ST-23/Surveillance Research	21,486	41,316	92%
62702E/TT-05/Advanced Targeting Technology	48,098	36,348	-24%
63226E/EE-36/Advanced ASW Technology	13,680	18,385	34%
63226E/EE-40/Critical Mobile Targets	104,553	124,654	19%
63226E/EE-41/Air Defense Initiative	27,717	40,600	46%
Total	215,534	261,303	21%

Rationale: The total Sensors effort increases by \$45.8 million in FY 1995. This is the result of ramp ups in the Critical Mobile Targets ATD, and expanded simulation and sensor evaluation programs in the ADI program. In addition, a non-proliferation surveillance demonstration project begins in FY 1995. The increase in Advanced ASW Technology funding is required to transition the project from laboratory to at-sea demonstrations of the three major ASW Technology program areas. These increases are offset by completion of the Ultra-Wideband radar research project.

**Technology Area of Science and Technology Projects
Advanced Research Projects Agency**

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: SURFACE/UNDERSURFACE VEHICLE

**FUNDING PROFILE
(\$, 000)**

<u>Program Element/Project/Title</u>	<u>FY 1994</u>	<u>FY 1995</u>	<u>Percent Change</u>
63226E/EE-39/Unmanned Undersea Vehicle Systems	17,952	17,839	-1%
63569E/AS-01/Advanced Submarine Technology	32,556	29,576	-9%
Total	50,508	47,415	-6%

Rationale: This Technology Area provides for the incorporation of advanced technologies in maritime vehicles. The FY 1995 ARPA SUBTECH Program decreases by \$3.0 million because of the transition of the Magnetic Levitation ATD to the Navy in FY 1994.

**Technology Area of Science and Technology Projects
Advanced Research Projects Agency**

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: ELECTRONIC WARFARE/DIRECTED ENERGY WEAPONS

FUNDING PROFILE
(\$, 000)

<u>Program Element/Project/Title</u>	<u>FY 1994</u>	<u>FY 1995</u>	<u>Percent Change</u>
62702E/TT-06/Advanced Tactical Technology	26,285	34,908	33%

Rationale: The Advanced Tactical Technology program funds technology development and application of lasers, microwave generators and mathematical algorithms for signal processing to improve the performance of critical electronic warfare, radar, electronic display, sensor and communication systems. The FY 1995 funding increase of \$8.6 million reflects increased development activity in Vacuum Electronics, Applied and Computational Mathematics, and Target Recognition programs, and transfer of the Holographic Data Storage project from PE 61101E, Project MS-01 to the Advanced Tactical Technology program. The Infrared Technology effort, formerly in Aeronautics Technology (TT-07) has also been transferred to the Advanced Tactical Technology program.

**Technology Area of Science and Technology Projects
Advanced Research Projects Agency**

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: BASIC RESEARCH - MATERIAL SCIENCE

FUNDING PROFILE
(\$, 000)

<u>Program Element/Project/Title</u>	<u>FY 1994</u>	<u>FY 1995</u>	<u>Percent Change</u>
61101E/MS-01/Materials Sciences	14,127	10,856	-23%

Rationale: The focus of the Material Science technology area is the development of new materials for advanced sources, composite structures, synthesis of polymers, development of electrochemical power and generation of advanced algorithms for Automatic Target Recognition. The FY 1995 reduction reflects the transition of the Holographic Data Storage project from 6.1 Basic Research to 6.2 Exploratory Development, and the consolidation of Biomedical efforts in the newly established Military Medical/Trauma Care technology project (MPT-07).

Technology Area of Science and Technology Projects Advanced Research Projects Agency

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: MATERIALS AND STRUCTURES

FUNDING PROFILE (\$, 000)

<u>Program Element/Project/Title</u>	<u>FY 1994</u>	<u>FY 1995</u>	<u>Percent Change</u>
62702E/TT-07/Aeronautics Technology	7,380	0	-100%
62712E/MPT-06/HTSC-High Temperature Superconductor	37,788	14,238	-62%
Total	45,168	14,238	-68%

Rationale: This Technology Area funds enabling technologies, primarily new materials, for more affordable, survivable weapon systems. The FY 1995 decrease in Aeronautics Technology, TT-07, reflects transition of the Phase I Speakeasy Radio Program to the Air Force and transfer of the Infrared Technology project to the Advanced Tactical Technology program (TT-06). The HTSC-High Temperature Superconductor program reduction reflects completion of funding for the HTSC-MCM project and reduced funding for the High Temperature Superconductor project as it nears completion.

**Technology Area of Science and Technology Projects
Advanced Research Projects Agency**

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: MILITARY MEDICAL/TRAUMA CARE TECHNOLOGY

FUNDING PROFILE
(\$, 000)

<u>Program Element/Project/Title</u>	<u>FY 1994</u>	<u>FY 1995</u>	<u>Percent Change</u>
62712E/MPT-07/Military Medical-Trauma Care Tech	0	26,016	100%

Rationale: The Military Medical/Trauma Care Technology project will exploit advances in electronics and information sciences to project advanced medical and surgical care into far-forward battlefield areas to permit early and successful clinical intervention. Technologies to be explored include personnel status monitors that transmit location and health data about individual soldiers, critical care pods for transporting injured personnel, data and communications systems linking forward deployed and rear echelon medical facilities, and combat care simulations to improve physician and medic training. This project has been established to consolidate existing ARPA funded biomedical programs into a single project to ensure program visibility and facilitate comprehensive program management. Previous efforts were funded in program elements 0601101E (MS-01, ES-01, CLS-02), 0602301E (ST-11), and 0602712E (MPT-01).

**Technology Area of Science and Technology Projects
Advanced Research Projects Agency**

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: ELECTRON DEVICES

**FUNDING PROFILE
(\$, 000)**

<u>Program Element/Project/Title</u>	<u>FY 1994</u>	<u>FY 1995</u>	<u>Percent Change</u>
63226E/EE-34/Guidance Technology	6,329	10,907	72%

Rationale: Two guidance technology projects, the Global Positioning System Guidance Package (GGP) program and the Common Grid program, are funded in the Electron Devices technology area in FY 1995. The GGP program will develop and demonstrate a tightly-coupled, miniature integrated navigation unit to support a broad range of DoD platforms including strike weapons, high-dynamic aircraft, and unmanned aerial vehicles (UAVs). A minor increase in FY 1995 is required to continue the program. Common Grid is a new initiative to provide regional/theater-wide precise time and position information to support precision strike forces (+\$3.0 million).

**Technology Area of Science and Technology Projects
Advanced Research Projects Agency**

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: BASIC RESEARCH - COMPUTER SCIENCES

**FUNDING PROFILE
(\$, 000)**

<u>Program Element/Project/Title</u>	<u>FY 1994</u>	<u>FY 1995</u>	<u>Percent Change</u>
61101E/CCS-02/Information Sciences	33,677	24,569	-27%

Rationale: This project supports the scientific study and experimentation that is the basis for more advanced knowledge and understanding in Information Sciences. This Technical Area includes programs in software technology, intelligent systems, robotics, and micro-electronic science. The majority of the \$9.1 million decrease in this technology area is attributable to reduced funding requirements for VLSI Science/Manufacturing and High Performance Computing Science basic research programs whose projects have matured and transitioned to 6.2 Exploratory Development.

Technology Area of Science and Technology Projects
Advanced Research Projects Agency

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: COMPUTERS

FUNDING PROFILE
 (\$, 000)

<u>Program Element/Project/Title</u>	<u>FY 1994</u>	<u>FY 1995</u>	<u>Percent Change</u>
62301E/ST-19/High Performance Computing	236,043	241,717	2%

Rationale: The FY 1995 Computer program continues the High Performance Computing project, an effort developing key high performance technologies that will be the foundation of the new Defense Science and Technology Thrust Area and will facilitate development of a national information infrastructure. An ongoing program, the overall growth of this technology area is approximately 2%.

**Technology Area of Science and Technology Projects
Advanced Research Projects Agency**

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: BASIC RESEARCH - ELECTRONICS

**FUNDING PROFILE
(\$, 000)**

<u>Program Element/Project/Title</u>	<u>FY 1994</u>	<u>FY 1995</u>	<u>Percent Change</u>
61101E/ES-01/Electronic Sciences	31,853	35,073	10%

Rationale: This technology area explores and demonstrates electronic, electronic device, circuit, and processing concepts to transmit, gather and process information. The goal of the program is to achieve substantial increases in performance while realizing a significant reduction in cost. The FY 1995 funding increase expands the Ultra-Electronics and Ultra-Photonics projects to facilitate the development of fabrication technologies for semiconductor laser and detector arrays, as well as ultra-fast electronic drive and processing circuits. This increase is essential to support the teraop communications requirements of the High Performance Computing and National Information Infrastructure programs.

**Technology Area of Science and Technology Projects
Advanced Research Projects Agency**

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: SIMULATION AND MODELING TECHNOLOGY

<u>Program Element/Project/Title</u>	<u>FUNDING PROFILE</u> (\$, 000)		<u>Percent Change</u>
	<u>FY 1994</u>	<u>FY 1995</u>	
63226E/EE-37/Advanced Simulation	55,993	80,368	44%
63744E/SM-01/Advanced Simulation, Nat'l Guard	9,207	21,431	133%
Total	65,200	101,799	56%

Rationale: The Simulation and Modeling technology area reflects an increase of \$36.6 million. The Advanced Simulation project increases by \$24.4 million to fund the Synthetic Theater of War Demonstration and the technology required to support it. The \$12.0 million increase in the Advanced Simulation, National Guard program restores the project to the FY 1993 funded level.

**Technology Area of Science and Technology Projects
Advanced Research Projects Agency**

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: SOFTWARE

**FUNDING PROFILE
(\$, 000)**

<u>Program Element/Project/Title</u>	<u>FY 1994</u>	<u>FY 1995</u>	<u>Percent Change</u>
62301E/ST-11/Intelligent Systems and Software	68,841	89,798	30%
62301E/ST-22/Software Engineering Technology	39,096	40,740	4%
Total	107,937	130,538	21%

Rationale: The \$22.6 million funding increase in the Software technology area is associated with the initiation of two projects within the Intelligent Systems and Software project: a Human Computer Interaction Research effort (+\$6.0 million) and an Education/Training System project (+\$4.0 million). In addition, the Manufacturing Systems/Infrastructure program, formerly in the Manufacturing Technology Initiative (MT-08) project has been transferred to the Intelligent Systems and Software (ST-11) project (+\$9.3 million). The balance of the increase is associated with increased funding requirements for the ongoing "Made in the USA" manufacturing initiative, and in baseline funding for the Software Engineering Institute.

**Technology Area of Science and Technology Projects
Advanced Research Projects Agency**

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: MANUFACTURING SCIENCE AND TECHNOLOGY

<u>Program Element/Project/Title</u>	<u>FY 1994</u>	<u>FUNDING PROFILE</u> <u>(\$, 000)</u>	<u>FY 1995</u>	<u>Change</u>
62708E/IC-03/High Definition Systems	57,214		50,000	-13%
62712E/MPT-01/Materials Processing Technology	81,047		110,197	36%
62712E/MPT-02/Electronic Processing Technology	80,489		105,929	32%
63226E/EE-43/Alternative Power Sources	0		10,000	100%
63570E/PT-99/Defense Reinvestment	324,000		325,000	0%
63739E/MT-02/MIMIC	80,181		17,188	-79%
63739E/MT-03/Infrared Focal Plane Array	41,429		45,100	9%
63739E/MT-04/Electronic Module Technology	98,080		132,648	35%
63739E/MT-05/Tactical Display Systems	9,467		15,407	63%
63739E/MT-06/Microwave and Analog Front End	0		36,002	100%
63739E/MT-07/Centers of Excellence	4,837		0	-100%
63739E/MT-08/Manufacturing Technology Initiatives	19,145		44,433	132%
63739E/MT-09/Dual-Use Design and Manufact. Tech.	0		30,554	100%
63739E/MT-10/Advanced Lithography	47,457		25,000	-47%
63745E/EM-01/Microelectronics Manufacturing	100,000		90,000	-10%
Total	943,346		1,037,468	10%

Rationale: The Manufacturing Science and Technology Area constitutes approximately 50% of the ARPA budget. The FY 1995 program increases approximately 10 percent, an increase attributable to the following: initiation of the Microwave and Analog Front End project (+\$36.0 million); expansion of the electromechanical systems (MEMS) manufacturing effort (+\$25 million); initiation of several new projects in advanced materials and environmental research (+\$27 million); continuation and expansion of the FDMMS and AESA ATDs (+\$30 million); continuation of the electric vehicle program (+\$10 million); and initiation of the Interferometric Fiber Optic Gyroscope Manufacturability (IFOG) ATD (+16 million). Offsetting these increases are reductions to the MIMIC program reflecting its completion after FY 1995 (-\$63 million); the Defense Reinvestment program (-\$49 million), a reduction that, with industry cost sharing, will maintain a \$500 million per year research effort; and termination of the Diamond Substrates and Metal Matrix and Ceramics projects.

**Technology Area of Science and Technology Projects
Advanced Research Projects Agency**

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: CONVENTIONAL WEAPONS

	FUNDING PROFILE (\$, 000)		Percent Change
<u>Program Element/Project/Title</u>	<u>FY 1994</u>	<u>FY 1995</u>	
62702E/TT-04/Close Combat Technology	28,300	22,444	-21%
62702E/EE-21/Close Combat	0	27,750	100%
Total	28,300	50,194	77%

Rationale: The projects funded within the Conventional Weapons technology area support lighter, more deployable equipment for Army conventional combat units. The FY 1995 funding increase is principally attributable to initiation of a four year Battlefield Management demonstration and continued development of Battlefield Management simulation technologies. Increased funding is provided for the Light Contingency Vehicle and Small Low Cost Intercept Device ATDs that are new starts in FY 1994. These increases are partially offset by the deletion of funding for the Diesel Turbo Engine project.

**Technology Area of Science and Technology Projects
Advanced Research Projects Agency**

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: AEROSPACE VEHICLES

**FUNDING PROFILE
(\$, 000)**

<u>Program Element/Project/Title</u>	<u>FY 1994</u>	<u>FY 1995</u>	<u>Percent Change</u>
63226E/EE-24/ASTOVL	19,712	19,039	-3%
63226E/EE-27/Advanced Space Technology Program	30,213	11,435	-62%
Total	49,925	30,474	-39%

Rationale: The FY 1995 Aerospace Vehicle technology area continues several demonstration efforts in manned aircraft and space programs. The Space Program decrease reflects termination of the ATSSB common bus and critical EHF component technologies ATDs.

SECTION IV

MANPOWER

EXHIBIT PB-4

ADVANCED RESEARCH PROJECTS AGENCY
FY 1994 Defense Budget Submission

SCHEDULE OF CIVILIAN AND MILITARY PERSONNEL

FY 1993 FY 1994 FY 1995 FY 1996 FY 1997 FY 1998 FY 1999

I. CIVILIAN PERSONNEL

RDT&E Defensewide	138	157	154	154	154	154	154
US Direct Hire							

II. MILITARY PERSONNEL

Officer, Army	2	4	3	3	3	3	3
Officer, Navy	5	4	4	4	4	4	4
Officer, Air Force	14	14	12	12	12	12	12
Officer Total	21	22	19	19	19	19	19
Total Military	21	22	19	19	19	19	19
TOTAL	159	179	173	173	173	173	173

SEPTEMBER 1993

ADVANCED RESEARCH PROJECTS AGENCY
CIVILIAN PERSONNEL COSTS
FY 1995 DEFENSE BUDGET SUBMISSION

FY 1992/93/94
(\$ in Thousands)

DATE: September 1993

APPROPRIATION: RESEARCH AND DEVELOPMENT

OP-08 Civilian Personnel

Prior Year (PY) - 1993

CP LN DESCRIPTION

CP LN	DESCRIPTION	CY END STRENGTH		WORK YEARS		CY		CY		CY		CY		CY		CY		CY	
		CY BEGIN STRENGTH	TOTAL	ETP	TOTAL	BASIC COMP	OVER TIME	HOL PBM	OTHER OC 11	TOTAL VARIAB	TOTAL OC 11	OC 12 BENEFIT	TOTAL COST	TOTAL OC 11	OC 12 BENEFIT	TOTAL COST	TOTAL OC 11	OC 12 BENEFIT	TOTAL COST
400 50 1	Senior Executive Schedule	23	22	22	23	2294	0	0	80	80	2374	368	2742	2374	368	2742	2374	368	2742
400 50 2	General Merit Pay	66	72	72	69.5	4888	0	0	82	82	4950	782	5732	4950	782	5732	4950	782	5732
400 50 3	All Other General Schedules	41	44	43	44	1227	45	0	30	75	1302	199	1501	1302	199	1501	1302	199	1501
400 50	Subtotal	130	138	137	136.5	8389	45	0	192	237	8626	1349	9975	8626	1349	9975	8626	1349	9975
400 50	Subtotal (Rate)					61.45788				0.02825	63.19414	0.16081	73.07692	63.19414	0.16081	73.07692	63.19414	0.16081	73.07692
400 50 4	Intergovernmental Personnel Act			17		2278					2278		2278	2278		2278	2278		2278
400 50	IPA (Rate)					134.00000					134.00000		134.00000	134.00000		134.00000	134.00000		134.00000
400 50	Total Civilian	130	138	137	153.5	10667	45	0	192	237	10904	1349	12253	10904	1349	12253	10904	1349	12253
400 50	Total Civilian (Rate)					69.49186				0.02222	71.03583	0.12646	79.82410	71.03583	0.12646	79.82410	71.03583	0.12646	79.82410

ADVANCED RESEARCH PROJECTS AGENCY
CIVILIAN PERSONNEL COSTS
FY 1995 DEFENSE BUDGET SUBMISSION
FY 1992/93/94
(\$ in Thousands)

DATE: September 1993

APPROPRIATION: RESEARCH AND DEVELOPMENT

OP-08 Civilian Personnel

Current Year (CY) = 1994

DP LN JBS CD II	DESCRIPTION	BY BEGIN			BY1 END STRENGTH			WORK YEARS			BY1 BASIC COMP	BY1 OVER TIME	BY1 HOL FHEM	BY1 OTHER OC.11	BY1 TOTAL VARIAB	BY1 TOTAL OC.11	BY1 OC 12 BENEFIT	BY1 TOTAL COST
		STRENGTH	TOTAL	FIP	TOTAL	FIP	TOTAL	FIP										
400 50 1	Senior Executive Schedule	22	25	24	23	22	2398	0	0	80	80	2478	385	2863				
400 50 2	General Merit Pay	72	90	86	82	81	5743	0	0	82	82	5825	880	6705				
400 50 3	All Other General Schedules	44	42	42	42	42	1171	45	0	28	73	1244	188	1432				
400 50	Subtotal	138	157	152	147	145	9312	45	0	190	235	9547	1453	11000				
400 50	Subtotal (Rate)						63.34694				0.02524	64.94558	0.15604	74.82993				
400 50 4	Intergovernmental Personnel Act				27.5		3741				3741			3741				
400 50	IPA (Rate)						136.03636				136.03636			136.03636				
400 50	Total Civilian	138	157	152	174.5	145	13053	45	0	190	235	13288	1453	14741				
400 50	Total Civilian (Rate)						74.80229				0.01800	76.14900	0.11132	84.47564				

FY 1992/93/94
(\$ In Thousands)

DATE: September 1993

OP-08 Civilian Personnel

DP IN TRES OF IT	DESCRIPTION
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ADVANCED RESEARCH PROJECTS AGENCY
CIVILIAN PERSONNEL COSTS
FY 1995 DEFENSE BUDGET SUBMISSION
FY 1992/93/94
(\$ in Thousands)

DATE: September 1993

APPROPRIATION: RESEARCH AND DEVELOPMENT

OP-06 Civilian Personnel

Budget Year Plus One (BY2) - 1996

DP LN
IBES 02 II DESCRIPTION

		BY2 END STRENGTH		WORK YEARS		BY2		BY2		BY2		BY2		BY2		BY2		BY2	
		B1 BEGIN				BASIC		OVER		HOL		OTHER		TOTAL		TOTAL		TOTAL	
		STRENGTH	TOIAL	FTE	FTE	COMP	TIME	FEEM	QC.11	VARIAB	QC.11	BENEFIT	QC.11	OC 12	OC.11	TOTAL	OC 12	TOTAL	OC.11
400 50	1	25	25	24	23	23	2480	0	0	85	85	2565	410	2975					
400 50	2	87	87	86	82	81	5925	0	0	90	90	6015	950	6965					
400 50	3	42	42	42	42	41	1227	50	0	35	85	1312	205	1517					
400 50		154	154	152	147	145	9632	50	0	210	260	9892	1565	11457					
400 50							65.52381					0.02699	67.29252	0.16248	77.93878				
400 50					35		4906					4906		4906					
400 50	4						140.17143					140.17143		140.17143					
400 50		154	154	152	182	145	14538	50	0	210	260	14798	1565	16363					
400 50							79.87912					0.01788	81.30769	0.10765	89.90659				